Arizona Department of Transportation

ARIZONA TRANSPORTATION Research Center

Estimated State Planning & Research Program
Part II – Research

Arizona Department of Transportation
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In cooperation with:

U.S. Department of Transportation
Federal Highway Administration

SPR-PL-1(175)
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(July 1, 2008 – June 30, 2009)

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Glossary of Acronyms and Abbreviations

Most of the acronyms and abbreviations shown in the following table are not defined in the main text of this publication. Please use this table as a reference for defining these terms.

AASHTO	American Association Of State Highway & Transportation Officials
AC	Asphaltic Concrete
ACFC	Asphalt Concrete Friction Course
ACMS	Advanced Construction and Maintenance Systems
ADEQ	Arizona Department of Environmental Quality
ADOT	Arizona Department of Transportation
AHRRC	Arizona Hospitality Research and Resource Center
AHS	Automated Highway Systems
ALISS	Accident Location Identification Surveillance System
APL	Approved Products List
AR-AC	Asphalt-Rubber Asphalt Concrete
AR-ACFC	Asphalt-Rubber/Asphalt-Concrete Friction Course
ARS	Arizona Revised Statutes
ASU	Arizona State University
ATC	Automatic Traffic Counter
ATIS	Advanced Traveler Information System
ATRC	Arizona Transportation Research Center
AVL	Automatic Vehicle Location: GPS-enabled technologies
BYU	Brigham Young University
Caltrans	California Department of Transportation
CCTV	Closed-Circuit TV
CIE	*Commission Internationale de L'Eclairage*
CRM	Crumb Rubber Modifier
CVISN	Commercial Vehicle Information Systems Network
DOT	Department Of Transportation
DPS	Department of Public Safety
ENTERPRISE	Evaluation of New Technologies for Roads Program Initiatives in Safety and Efficiency
FHWA	Federal Highway Administration
FM	Frequency modulation
FWD	Falling Weight Deflectometer
FY	Fiscal Year
G4	A type of guard rail
GCNP	Grand Canyon National Park
GIS	Geographic Information System
GOHS	Governor’s Office of Highway Safety
GPS	General Pavement Studies
GPS	Global Positioning Satellite
GTSAC	Governor’s Traffic Safety Advisory Council
HAR	Highway Advisory Radio

HCRS	Highway Condition Reporting System
HMA	Hot Mix Asphalt
HMAC	Hot Mix Asphaltic Concrete
HOV	High Occupancy Vehicle
HPC	High Performance Concrete
HPS	High-Pressure Sodium
IDMS	Integrated Document Management System
IES	Illuminating Engineering Society
ISPMMS	Integrated Sign and Pavement Marking Management System
ITD	Intermodal Transportation Division
ITEP	ITS, Traffic & Safety, Environment, Planning
ITG	Information Technology Group
ITS	Intelligent Transportation System
IV	Intelligent Vehicle
JLBC	Joint Legislative Budget Committee
JPA	Joint Project Agreement
LOS	Level Of Service
LPS	Low-Pressure Sodium
LTAP	Local Technical Assistance Program
LTPP	Long Term Pavement Performance
MAG	Maricopa Association of Governments
MH	Metal Halide
MOE	Measures Of Effectiveness
MP	Milepost
MSE	Mechanically-Stabilized Earth
MSM	Materials, Structures, and Maintenance
MPD	Multimodal Planning Division
MUTCD	Manual of Uniform Traffic Control Devices
MVD	Motor Vehicle Division
N/A	Not Applicable
NAU	Northern Arizona University
NCAT	National Center for Asphalt Technology
NCHRP	National Cooperative Highway Research Program
NOAA	National Oceanographic and Atmospheric Administration
NTCIP	National Transportation Communications for Intelligent Transportation Systems Protocol
NTPEP	National Transportation Product Evaluation Program
OGFC	Open-Graded Friction Courses
P3	Pollution Prevention Plan
PC	Personal Computer
PIJ	Project Investment Justification
PM10	Particulate Matter less than 10 microns in diameter
PM2.5	Particulate Matter less than 2.5 microns in diameter
PMS	Pavement Management System
PRIDE	Product Resource Investment Deployment And Evaluation
R&D	Research & Development

R/W	Right-Of-Way
RFP	Request For Proposal
RV	Recreational Vehicle
RWIS	Roadway Weather Information System
SAFETEA-LU	Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users
SGC	Sand-Gravel-Cobbles
SHRP	Strategic Highway Research Program
SHSP	Strategic Highway Safety Plan
SNAFU	Situation Normal, Activity Focus Unchanged
SPR	State Planning & Research
SPS	Specific Pavement Studies
SPUI	Single-Point Urban Interchange
SR	State Route
TAC	Technical Advisory Committee
TBD	To be determined
TEA-21	Transportation Equity Act for the 21st Century
TI	Traffic Interchange
TNM	Traffic Noise Model
TRB	Transportation Research Board
TTI	Texas Transportation Institute
UDOT	Utah Department of Transportation
VMS	Variable Message Sign
VOC	Volatile Organic Compound
VSL	Variable Speed Limit
WASHTO	Western Association of State Highway & Transportation Officials
WIM	Weigh-In-Motion
WSDOT	Washington State Department of Transportation

Overview

The Arizona Transportation Research Center (ATRC) directs the Arizona Department of Transportation (ADOT) research program.

ATRC MISSION — The ATRC mission is to pursue and share knowledge in transportation systems and programs.

ATRC VISION — ATRC sets the national standard of excellence for transportation research, product evaluation and library services.

The research program encompasses seven research emphasis areas:

- Environment
- Intelligent Transportation Systems
- Maintenance
- Materials & Construction
- Planning & Administration
- Structures
- Traffic & Safety

The research program also includes the ADOT Product Resource Investment Deployment and Evaluation (PRIDE) program. The review and acceptance of new products for possible use by ADOT is coordinated through the PRIDE program. The Approved Products List (APL) is also maintained under the PRIDE program.

ATRC houses and operates the main ADOT library. The library is maintained by a full time librarian. The ATRC Library is open to ADOT employees, transportation faculty in Arizona universities, and Arizona local and county transportation staff.

The library catalogue is available on the Internet. The library collection currently includes nearly 30,000 entries, including over 60 journal and magazine subscriptions.

This ATRC annual report provides descriptions and progress updates for new and ongoing projects in the Fiscal Year (FY) 2009 *Estimated State Planning & Research (SPR) Program, Part II*. A total of 78 research projects and 16 research support programs are included in this year's program.

The Research Support section of this document provides a brief overview of budgets outside the direct research studies encompassed by the seven research emphasis areas. New program elements this year include support for ADOT meeting participation (SPR-114). Carry over funds in this account are from the technical editor budget. ATRC now has a technical editor on staff so this budget was reallocated to the meeting participation budget. Also new is the Director's Special Projects fund (SPR-995). This was recommended by the Research Council and provides funding for projects identified by ADOT executive management at any time during the year.

Twenty-two project reports were published during FY 2008. A list of these projects is shown in Table 1.

TABLE 1
Fiscal Year 2008 Completed Research Projects

ID #	Title	Project Manager
SPR-402	*SPR-402, Development of Performance Related Specifications for Asphalt Pavements*	Dimitroplos
SPR-473	*Arizona Intelligent Vehicle Systems Evaluation*	Owens
SPR-524	*Development of Mix Design Proceedures and End Product Specifications for Gap-Graded Asphalt-RubberAsphalt Concrete*	Dimitroplos
SPR-534	*Digital Signature Feasibility Study*	Semmens
SPR-540	*Evaluation of Measures to Minimize Wildlife Vehicle Collisions and Maintain Wildlife Permeability Across Highways*	Kombe
SPR-544	*What is the Best Mix of Service delivery Strategies that Can Be Employed to Reduce Customer Time in Motor Vehicle Division Field Offices?*	Semmens
SPR-574	*Use of NDT Equipment for Construction Quality Control of Hot Mix Asphalt Pavements*	Dimitroplos
SPR-591	*High Crash Risk Unsignalized Intersections*	Harris
SPR-592	*Building Tribal Traffic Safety Capacity*	Harris
SPR-593	*Development and Implementation of a Regional Safety Management Database*	Harris
SPR-597	*Highway Safety Incentive Report*	Harris
SPR-598	*Should State DOTs Prefer Bicycle Lanes or Wide Curb Lanes?*	Semmens
SPR-608	*Development of Rational Pay Factors Based on Concrete Compressive Strength Data*	Dimitroplos
SPR-609	*Driver Education for Safety in Adverse Driving Conditions*	Semmens
SPR-610	*Implementing a Statewide Rideshare and Vanpool Program in Arizona*	Semmens
SPR-612	*Evaluate Effectiveness of Cattle Guards and Fencing*	Harris
SPR-614	*Origins and Destinations Study of Older Persons*	Semmens
SPR-615	*ITS Concepts for Rural Corridor Operations*	Owen
SPR-629	*Analysis of Capacity and Operations after Retrofit Improvements of Happy Valley and I-17 Roundabout Traffic Interchange*	Harris
SPR-635	*Improved Efficiency Through Driving Simulator Training*	Owen
SPR-637	*Cost/Benefit Analysis of Electronic License Plates*	Semmens
SPR-639	*Effectiveness of Various Pre-Emergent Herbicides*	Semmens

Further information on these completed projects may be obtained from the project managers. Copies of the completed reports may be obtained from the ATRC Librarian. Telephone numbers and e-mail addresses for ATRC staff are shown in Table 2. Reports are also available on the Internet at: http://www.azdot.gov/TPD/ATRC/publications/index.asp

TABLE 2
ATRC CONTACT INFORMATION

ATRC STAFF	PHONE NUMBERS	E-MAIL ADDRESSES
Manager		
Frank Darmiento	602-712-3134	fdarmiento@azdot.gov
Project Managers		
Christ Dimitroplos	602-712-7850	cdimitroplos@azdot.gov
Jason Harris	602-712-6927	jharris@azdot.gov
Estomih (Tom) Kombe	602-712-3135	ekombe@azdot.gov
Vacant	602-712-6910	
Vacant	602-712-3137	
Librarian		
Dale Steele	602-712-3138	dsteele@azdot.gov
Technical Support		
Evelyn Howell – Technical Editor	602-712-6346	ehowell@azdot.gov
Christopher Gass – Field Data Technician	602-712-6348	cgass@azdot.gov
PRIDE Program Engineering Assistant	602-712-6430	
FAX	602-712-3400	

Departmental Oversight of ATRC

The ADOT Research Council oversees the research effort. The Research Council evaluates and rates proposals for new research, including pooled fund projects, thereby selecting new research projects. The Council monitors project activity and implementation and provides guidance to ATRC on the research program. The Council reviews technical advisory committee membership for research projects. The Council typically meets during June to evaluate the major project proposals (budgets greater than $25,000) and holds two other business meetings during the spring and fall.

Membership in the Research Council is voluntary. With the exception of the FHWA Arizona Division, there are no automatic or organizational positions on the Council. Members are appointed by the ATRC Manager.

Research Council members are shown in the Table 3.

TABLE 3
Research Council

Name	Group
Julio Alvarado	Construction Group
Matthew Burdick	Director, Communication & Community Partnerships
John Carlson	Motor Vehicle Division
Frank Darmiento – chairman	Transportation Research Center
Jim Delton	State Materials Engineer
Doug Forstie	Deputy State Engineer – Operations
Lonnie Hendrix	State Maintenance Engineer
Karen King	Federal Highway Administration
Mike Manthey	State Traffic Engineer
Sam Maroufkhani	Deputy State Engineer – Development
Jean Nehme	State Bridge Engineer
Scott Nodes	Transportation Technology Group
Floyd Roehrich, Jr.	State Engineer
Suzan Tasvibi-Tanha	Information Technology Group
Rakesh Tripathi	Director, Multimodal Planning Division
Mary Viparina	Assistant State Engineer – Roadway
Todd Williams	Director, Office of Environmental Services

Financial and statistical data are presented in the *SPR Program Budgets* and *Program Statistics* sections. The amount of new funding for FY 2009 is estimated at approximately $3,440,383. As of June 30, 2008, a total of about $5,998,692 is available in funds carried forward from prior programs.

Summaries of current as well as proposed new SPR projects are presented for each of the seven research emphasis areas, grouped by emphasis area. Information regarding other types of projects may be found in the *Research Support Programs and Pooled Fund Program* sections, respectively.

Also included in this Report is the *Publications Catalog for the Arizona Transportation Research Center,* which lists all of the currently available research reports published by ATRC.

Publications

In addition to final research reports, ATRC publishes the following items:

- Research notes—Four page summaries of individual research reports
- Quarterly newsletter
- Quick Studies—Results of fast, low cost research on issues ADOT faces
- Annual Implementation Report—presentation of application of research
- Research Program Manual—Policies and procedures governing State Planning and Research projects at the Arizona Transportation Research Center
- Annual SPR Book—Annual report on research projects underway at the Arizona Transportation Research Center.
- PRIDE Program Annual Report—Annual report of ADOT's Product Resource Investment Deployment and Evaluation (PRIDE) Program.
- Peer Exchange Reports—Reports produced as a result of FHWA peer exchange program.

Budgets

The following tables summarize the financial status of each of the ongoing ATRC projects. Each project is identified by number and title. Funds carried over from previous years and funds to be provided by the fiscal year 2008 allocation are estimated for each project.

Each project is classified in one of the following categories: E: Environment, I: Intelligent Transportation Systems (ITS), M: Maintenance, MC: Materials and Construction, P: Planning and Administration, R: Research Support, ST: Structures, and T: Traffic and Safety.

State Planning & Research Funded Program

ID No.	Project Name	Area[1]	Carry Over[2]	FY 2009 Funds
SPR-110	*ATRC Library Resources*	R	90,404	30,000
SPR-111	*Transportation Research Board Correlation/AASHTO* [3]	R	7,240	140,000
SPR-112	*Administration of Research*	R	119,285	30,000
SPR-113	*Support Staff Salaries*	R	128,167	275,000
SPR-114	*ADOT Meeting Support*	R	26,480	10,000
SPR-116	*PRIDE*	R	130,456	40,000
SPR-117	*Local Technology Assistance Program*	R	49,496	68,000
SPR-118	*Transportation Research Quick Study Program*	R	25,008	15,000
SPR-124	*Research Traffic Data Collection*	R	217,196	100,000
SPR-125	*NCHRP* [3]	R	- 0 -	760,000
SPR-127	*Small Budget Studies*	R	20,000	200,000
SPR-396	*LTPP and Other Test Section Management and Evaluation*	MC	198,000	- 0 -
SPR-493	*Bridge Foundation Design Parameters, SGC Bearing Materials*	ST	34,212	- 0 -
SPR-500	*Aggregate Sources in Northern Arizona*	M	133,411	- 0 -
SPR-535	*Safety Information Exchange System for the Nogales Port of Entry*	P	142,400	- 0 -
SPR-536	*Improved Snow Plow Headlight Visibility and Reduced Driver Fatigue*	M	44,600	- 0 -
SPR-538	*High Performance Concrete for Bridge Structures in Arizona*	ST	14,800	- 0 -
SPR-547	*Arizona Statewide Safety Project Analysis Model*	P	15,291	- 0 -
SPR-571	*Options for Reducing ADOT's Legal Liability Costs*	P	27,400	- 0 -
SPR-575	*Concrete Aggregate Durability Study*	MC	19,994	- 0 -
SPR-577	*Pavement Noise Study*	MC	97,000	- 0 -
SPR-583	*Open Source Software Study*	P	9,199	- 0 -
SPR-584	*Survey of Traffic Noise Reduction Products, Materials and Technology*	E	2,818	- 0 -

ID No.	Project Name	Area[1]	Carry Over[2]	FY 2009 Funds
SPR-586	*Investigation of Earth Pressure on Concrete Cantilever Retaining Wall for Variable Quality Backfill*	ST	150,000	- 0 -
SPR-587	*Evaluation of Salvage and Replanted Native Plants on ADOT Projects*	E	54,730	- 0 -
SPR-588	*A Study of the Effectiveness of Bighorn Sheep Underpasses on State Route 68*	E	13,972	- 0 -
SPR-589	*Determination of 404 Permit Requirements and Habitat Restoration Requirements*	E	77,169	- 0 -
SPR-590	*Performance Related Pay Factors for Asphalt Concrete*	MC	- 0 -	- 0 -
SPR-600	*Evaluating the Effectiveness of Microbe Application to Petroleum Spills at Crash Sites*	E	10,500	- 0 -
SPR-601	*Cost Evaluation of Cross-Border Truck Emissions Testing using Heavy Duty Remote Sensing (HDRS) Equipment*	E	990	- 0 -
SPR-602	*Sampling and Analyses of Storm Water Runoff*	E	6,796	- 0 -
SPR-603	*Continued Evaluation of Measures to Minimize Wildlife-Vehicle Collisions & Maintain Wildlife*	E	19,280	- 0 -
SPR-604	*Real-Time Adaptive Ramp Metering: Phase 2– Implementation and Enhancement*	I	101,006	- 0 -
SPR-605	*Investigations of Environmental Effects on Freeway Acoustics*	MC	0	- 0 -
SPR-606	*Implementation Of The Mechanistic-Empirical (M-E) Design Guide For Arizona*	MC	226,000	- 0 -
SPR-613	*Quantifying the Impact of Opening a New Segment of Freeway*	P	4,740	- 0 -
SPR-617	*Evaluate Effect of De-icing Chemicals on Rubberized Pavements*	M	80,652	- 0 -
SPR-618	*Land Use and Traffic Congestion*	P	81,100	- 0 -
SPR-619	*Antelope Movements North of Interstate 40 in Arizona*	E	144,344	- 0 -
SPR-623	*Increasing Vehicle Registration Compliance and Revenue through Proactive Identification*	P	11,625	- 0 -
SPR-624	*Hazardous Materials Transportation in Arizona*	E	53,000	- 0 -
SPR-625	*Safety Enhancements for Median Crossovers*	T	30,000	- 0 -
SPR-626	*State Route 64 Wildlife Accident Reduction Study Monitoring*	E	99,449	- 0 -
SPR-627	*State-of-the-Art Evaluation of Traffic Detection and Monitoring Systems*	I	133,086	- 0 -
SPR-628	*Evaluation of Maintenance Strategies for ADOT*	M	51,875	- 0 -
SPR-630	*Critical Review of ADOT's Hot Mix Asphalt Specifications*	MC	69,000	- 0 -
SPR-631	*Evaluate Warm Mix Technology for use in Asphalt Rubber – Asphaltic Concrete Friction Courses (AR-ACFC)*	MC	150,000	- 0 -

ID No.	Project Name	Area[1]	Carry Over[2]	FY 2009 Funds
SPR-632	*Development of Materials for Repairing AR-ACFC Surfaces*	M	100,000	- 0 -
SPR-633	*Economical Concrete Mix Designs Utilizing Blended Cements, Performance Based Specifications, and Rational Pay Factors*	MC	120,000	- 0 -
SPR-634	*A Platform for Evaluating Emergency Evacuation Strategies*	I	17,114	- 0 -
SPR-636	*"Heat Island" Effect of Pavements*	P	41,000	- 0 -
SPR-640	*Cost-Effectiveness of Mobile Enforcement*	P	11,963	- 0 -
SPR-641	*Oversized Vehicle Study*	P	15,000	- 0 -
SPR-642	*Delivery of a Technical Curriculum Using Learner-Based Instruction and Communication Modalities in a Distributed Environment*	P	24,000	- 0 -
SPR-643	*Evaluation of Yellow Left-Turn Arrow Phasing and Flash Options*	I	24,500	- 0 -
SPR-644	*Continuum Damage Theory applied for Asphalt Rubber Mixtures*	MC	25,000	- 0 -
SPR-645	*Automatic Vehicle Location (AVL) and Maintenance Work Effort Tracking*[6]	I	78,341	- 0 -
SPR-646	*AASHTOWare Turborelocation Software Development*	P	100,000	- 0 -
SPR-647	*Elk Movements Associated with a High-Traffic Highway: Interstate-17*	E	250,000	- 0 -
SPR-648	*Crash Related Education, Enforcement, and Engineering Factors*	T	120,000	- 0 -
SPR-649	*Safety Issues Due to Unforeseen Stoppage of High Speed Mainline Traffic*	M	60,000	- 0 -
SPR-650	*Predicting Desert Tortoise (Gopherus agassizzii) Habitat and Identifying Movement Patterns within the Proposed Highway 95 Realignment*	E	310,267	- 0 -
SPR-651	*Incorporating safety performance into project design decision-making for cost effective safety enhancements*	T	50,000	- 0 -
SPR-652	*Countermeasures to Reduce Large Truck Crashes*	T	100,000	- 0 -
SPR-653	*Arizona VII Initiative: Proof of Concept/Operational Testing*	I	192,775	- 0 -
SPR-654	*Options & Impacts of Measures to Reduce Single-Occupant Vehicle (SOV) Traffic*	P	42,433	- 0 -
SPR-655	*Identifying Customer-Focused Performance Measures*	P	100,000	- 0 -
SPR-656	*Asphalt Rubber Mixtures Susceptibility to Moisture Damage*	MC	25,000	- 0 -
SPR-657	*Options for Reducing Copper Theft*	P	9,107	- 0 -
SPR-658	*Performance Testing of HPC on the Sunshine Bridge Project*	MC	5,000	- 0 -

ID No.	Project Name	Area[1]	Carry Over[2]	FY 2009 Funds
SPR-659	*Genetic Variation of Pronghorn across US Highway 89 and State Route 64*	E	15,000	- 0 -
SPR-660	*Arizona Transportation History*	P	25,000	- 0 -
SPR-661	*Engineering Design Methods to Mitigate Damages from Earth Fissures*	MC	25,000	- 0 -
SPR-662	*Cost Effectiveness of MVD Fee Collections*	P	25,000	- 0 -
SPR-663	*SB2008-29: Development of Intersection Performance Measures for Timing Plan Maintenance Using an Actuated Controller – Phase I*	T	25,000	- 0 -
SPR-670	*SB2008-30: Restraint Use (Seat belt and child passenger seats) Survey*	T	25,000	- 0 -
SPR-671	*Data Analysis Methodology to Identify Effective Countermeasures for Reducing Fatalities and Injuries on Arizona Roadways*	T	- 0 -	100,000
SPR-672	*Development of a Traffic Data Input System in Arizona for the Mechanistic Empirical Pavement Design Guide*	MC	- 0 -	150,000
SPR-673	*Performing Lifecycle Cost Analysis of HPC and Developing HPC Specifications for ADOT Bridge Projects*	MC	- 0 -	175,000
SPR-674	*Engineering Properties of Recycled ARFC Overlays*	MC	- 0 -	75,000
SPR-675	*Effectiveness of Young Driver Training and Graduated Licensing Laws*	T	- 0 -	80,000
SPR-676	*Assessing How "New Media" Can Bolster ADOT's Outreach and Communication Effectiveness*	P	- 0 -	125,000
SPR-677	*Evaluation of Measures to Promote Desert Bighorn Sheep Permeability: US Highway 93*	E	- 0 -	185,000
SPR-678	*Dynamic Routing for Incident Management*	I	- 0 -	50,000
SPR-679	*Platform for Evaluating Emergency Evacuation Strategies - Phase II*	I	- 0 -	200,000
SPR-680	*Development of Intersection Performance Measures for Timing Plan Maintenance Using an Actuated Controller – Phase II: Data Collection*	T	- 0 -	75,000
SPR-681	*Work Zone Instant Driver Warnings: Speed or Penalty Messages*	I	- 0 -	62,500
SPR-682	*Analysis of Freeway Bottlenecks: Capacity Reduction and Temporal Variations*	I	- 0 -	80,000
SPR-683	*Feasibility Test of CAD Web Menus*	P	- 0 -	75,000
SPR-995	*Director's Special Projects*	R	- 0 -	50,000
SPR-996	*Project additions*	R	- 0 -	40,000
SPR-997	*Participation Projects* [4]	R	- 0 -	50,000
SPR-998	*Budget Closeout Funds*	R	250,000	100,000
SPR-999	Contingency	R	533,149	99,883
	TOTALS		5,866,820	3,440,383

Table Notes:

[1] Abbreviations under Area refer to program areas – E: Environment, I: Intelligent Transportation Systems (ITS), M: Maintenance, MC: Materials and Construction, P: Planning and Administration, R: Research Support, ST: Structures, T: Traffic and Safety

[2] Includes amounts newly transferred into projects from earlier program years' contingency funds and non-SPR funding. All carryover amounts for these and other projects are as of 06/30/2007.

[3] Funded with 100% Federal funds.

[4] If any new pooled fund projects are approved, up to $50,000 will be allocated from this account. Previously approved funding includes: Pooled Fund Study SPR-3(020), *IVHS Study (ENTERPRISE)*— $30,000 (FY2009).

Statistics

There were 21 project completions accounting for a budget of $ 1,169,845 during FY 2007 (July 1, 2006 through June 30, 2007). The distribution of these projects by emphasis area is shown below.

FY 2008 Project Completion Summary

Category	No. of Projects	Funds Spent
Environment	1	$344,000
ITS	3	$452,634
Maintenance	1	7,637
Materials & Construction	4	$1,332,150
Planning & Administration	8	$557,000
Structures	0	0
Traffic & Safety	4	$313,250
Totals	**21**	**$3,006,671**

There are 79 ADOT project research studies in the current program.

Current Research Projects

Category	Number of Projects	Budget ($)
Environment	15	1,243,315
ITS	10	939,322
Maintenance	6	470,538
Materials & Construction	16	1,359,994
Planning & Administration	19	885,258
Structures	3	3,736,636
Traffic & Safety	9	199,012
TRQS [1]	1	5,000

[1] TRQS denotes Transportation Research Quick Study

Environment – PROJECTS

SPR-584, *Survey of Traffic Noise Reduction Products, Materials, and Technologies*

Research Agency:	Prophecy Consulting Group	FY Authorization:	2005
Principal Investigator(s):	Violettee (Vi) Brown	Contract Date:	12/27/04
Contract Amount:	$7,980.00	Original Completion Date:	06/2006
Program Budget:	10,000.00	Estimated Completion Date:	08/31/2008
Expenditures to date:	$7,182.01	Is project on schedule?	No
Available Amount:	$2817.99	ADVANTAGE No.	R058417P
Percent complete Through 6/30/08	95%	Responsible ATRC Staff: (Project Manager)	Tom Kombe

PROBLEM STATEMENT

One of the most effective methods of controlling traffic noise is to reduce the noise generated at the source. One means to accomplish this is to absorb the sound on or near the roadway. Alternative noise barrier designs and treatments have been successfully utilized in other states and throughout Europe for a number of years to address different performance needs. In some situations these designs allow for the initial construction of a noise wall to be lower in height than a traditional wall. Also, retrofitting an existing wall with an innovative top section can reduce noise levels and eliminate the need for costly wall height increases or wall replacements. However, there is no comprehensive compilation of information on such traffic noise reduction products, materials, and designs.

RESEARCH OBJECTIVES

1. Determine what noise reduction products, materials, and technologies are currently available that have potential as noise mitigation alternatives.
2. Compile available performance information and discuss whether a full-scale testing program by the department is recommended.

EXPECTED IMPLEMENTATION

Based on the results of the tasks in this project, an assessment of the expected growth in the acceptability and use of the alternative noise mitigation approaches will be completed. The nature of, and amount of available quality performance information will also be determined. Recommendations will be developed on how ADOT can best proceed on this and whether a full-scale testing program is needed. Should such a testing program be recommended, ADOT will evaluate and decide accordingly.

STATUS OF THE RESEARCH

A Final report for the project was submitted for review by the TAC and FHWA both of which have approved. Another review by a technical editor was completed. (August 11, 2008) The report is in queue for publishing as soon as final format review is completed.

Environment

TECHNICAL ADVISORY COMMITTEE (TAC)

Barney Remington – ADOT Environmental & Enhancement Group
Fred Garcia – ADOT Environmental & Enhancement Group
Steve Thomas – Federal Highway Administration
Frank Darmiento – Transportation Research Center
Estomih (Tom) Kombe – ATRC Project Manager

SPR-587, *Evaluation of Salvage and Replanted Native Plants on ADOT Projects*

Research Agency:	Logan Simpson Design, Inc.	FY Authorization:	2005
Principal Investigator(s):	Judy Melke, RLA	Contract Date:	06/05/2007
Contract Amount:	$74,973	Original Completion Date:	03/31/2009
Program Budget:	$75,000	Estimated Completion Date:	03/31/2009
Expenditures to date:	$20,243	Is project on schedule?	Yes
Available Amount:	$54,730	ADVANTAGE No.	R058717P
Percent complete Through 6/30/08	35%	Responsible ATRC Staff: (Project Manager)	Tom Kombe

PROBLEM STATEMENT

ADOT in the construction of highway projects over the last 10 years has transplanted substantial quantities of plant species that provide a major contribution to the area ecosystem and visual quality of highway projects. The cost of this planting on many projects can run $200,000 to $300,000 per mile. On SR 87 and US 93 heavy emphasis was placed on salvaging and transplanting of Saguaros, Ocotillo, Barrel and Yucca and some native trees. The plants salvaged and replanted on projects are watered one or two years after replanting as plant establishment. Because of the nature of the plants they may not show survival or mortality until they have been in the ground for 3 to 8 years. Since a number of plantings have been in the ground 5 to 10 years an inventory based on the projects' plantings with an evaluation of survival and mortality would benefit the planning, design and construction of projects.

The salvage and replanting of plant materials can have a major visual and ecosystem effect on projects. At the present time no evaluations have been made that can contribute to our knowledge basis and towards improvement of project design. The Department annually spends several hundred thousand dollars per mile on salvaging and replanting on projects throughout the state. This would be a valuable expenditure when considering the cost for success and failure related to planting and re-establishment of these unique plants on highway projects

The resulting benefits would include the following:

- Since many of the species planted are in a time period when their survival or mortality can be determined, assessing the survival and mortality rate would provide information on species that salvage well and have a high level of survival.
- Research the contributing factors for survival and mortality.
- Develop additional criteria selection for salvage for replanting.

RESEARCH OBJECTIVES

1. Quantify survivability rates of transplanted saguaros, ocotillos, barrels, and trees on selected ADOT projects.
2. Quantify and compare survival rate of move-once saguaros to move-twice saguaros.
3. Determine the cost effectiveness of salvaging move-once and move-twice saguaros.
4. Quantify and compare the survival rates of small cacti and large cacti.

5. Determine cost-effectiveness of salvaging small and large cacti

EXPECTED IMPLEMENTATION

ADOT has a number of projects now reaching an age where salvage and replanting materials could be evaluated to provide effective determinations. An evaluation of salvage techniques and establishment techniques would enable the Department monies to be spent more effectively.

STATUS OF THE RESEARCH

Project effort is on-going with good progress. During the data collection phase (Fall 2007) two consultation meeting were held between the consulting team and the technical advisory committee.

TECHNICAL ADVISORY COMMITTEE (TENTATIVE)

LeRoy Brady,	Roadside Development, ADOT (Champion);
Representative -	Tonto National Forest;
Vicki Bever	Natural Resource, ADOT;
Michael Daehler -	EEG, ADOT.
Steve Thomas	FHWA
Mathew Moul	ADOT Globe District
Ted Littlefield	ADOT
Zitao Fang	ADOT, Roadside Development
Estomih Kombe	ADOT Project Manager, ATRC

SPR-588, *A Study of the Effectiveness of Big Horn Underpasses on State Route 68*

Research Agency:	AZ G&F Department	FY Authorization:	2005
Principal Investigator(s):	Jim DeVos	Contract Date:	08/09/2005
Contract Amount:	$175,000	Original Completion Date:	12/31/2007
Program Budget:	$175,000	Estimated Completion Date:	08/31/2008
Expenditures to date:	$161,027.80	Is project on schedule?	Yes
Available Amount:	$13,972.20	ADVANTAGE No.	R058817P
Percent complete Through 6/30/08	95%	Responsible ATRC Staff: (Project Manager)	Tom Kombe

PROBLEM STATEMENT

Habitat fragmentation by highways generally creates species declines. For bighorn sheep, size of contiguous habitat is a critical factor determining population persistence. Arizona consists of 32 isolated bighorn sheep ranges of varying sizes, the Black Mountains in northwestern Arizona being the largest (>500,000 acres). The range contains the largest desert sheep herd in the U.S., and represents 31% of Arizona's sheep population. The Black Mountain herd also provides an important source population for transplants. Upgrades to SR 68 and U.S. 93 could create three smaller isolated patches of bighorn sheep habitat in the Black Mountains

Highway underpasses are used nationally to mitigate the effects of habitat fragmentation, yet few performance evaluations have been conducted (Foreman et al. 2003). Two underpasses were installed in the Black Mountains along SR 68 for wildlife crossing; however, their effectiveness remains largely unknown. Little is known about bighorn sheep use of underpasses elsewhere, or the factors that influence sheep use of crossing structures. Information is needed to ensure proper placement and design of passages on this and future highway projects planned in the Black Mountains.

RESEARCH OBJECTIVES

1. Quantify the effectiveness of SR 68 highway underpasses in facilitating bighorn sheep habitat connectivity in the Black Mountains.
2. Determine physical and biological factors that influence bighorn sheep use of these underpasses.
3. Recommend modification to wildlife crossing structures if necessary.

EXPECTED IMPLEMENTATION

With the results of this evaluation ADOT will be able to make informed decisions when opportunities arise during maintenance and new roadway constructions, for the upgrade to and installation of wildlife crossing structures of proven effectiveness.

STATUS OF THE RESEARCH

A draft final report was reviewed by the technical advisory committee and a final report submitted to FHWA for review and approval. The report was also reviewed by a technical editor. At this time (August 11, 2008) the final report is in queue for final format review prior to publication.

Environment

TECHNICAL ADVISORY COMMITTEE (TAC)

Kara Hinker	ADOT, Kingman District
John Reid,	Bureau of Land Management
Terry Brennan	US Forest Service
Jim Holland	U.S. National Park Service
Justin White	ADOT Environmental & Enhancement Group
Melissa Maiefski	ADOT Environmental & Enhancement Group
Steve Thomas	Federal Highway Administration
Jim DeVos	AZ Game & Fish Department

SPR-589, *Determination of 404 Permit and Habitat Restoration Requirements*

Research Agency:	EcoPlan Associates, Inc.	FY Authorization:	2005
Principal Investigator(s):	George A. Ruffner, Ph.D	Contract Date:	04/27/2007
Contract Amount:	$110,558.00	Original Completion Date:	06/30/2008
Program Budget:	$125,000.00	Estimated Completion Date:	12/31/2008
Expenditures to date:	$33,389.27	Is project on schedule?	Yes
Available Amount:	$77,168.73	ADVANTAGE No.	R058917P
Percent complete Through 6/30/08	40%	Responsible ATRC Staff: (Project Manager)	Tom Kombe

PROBLEM STATEMENT

ADOT recognizes that with the construction of highway projects and to waters of the U.S. and important habitat areas that there is an opportunity to re-establish and enhance quality wildlife habitat areas. The present Permits frequently require planting on a replacement of 3 to 1 with up to 80% survival in the fifth year of the permit. Based on review of these permit areas it is becoming apparent that these requirements are beyond a naturally sustainable level with a number of projects falling short of these requirements. Since habitat and native planting has not been studied these criteria are based on assumptions beyond what the various ecological systems appear to be able to support especially in a drought.

The present 7-year drought that we are experiencing has a very direct effect on the survivability of the plantings. At the present time no one area can provide information from which to make evaluations and determinations which would provide a basis for new project plantings and specifications. Values that are appearing with projects require additional time and effort of the various staff resources in setting up new projects and addressing value issues.

The resulting benefits would include the following:

- ADOT will be able to develop guidelines that recognize most successful species for planting for habitat restoration.
- Restoration of areas has a benefit not only to wildlife but also from a visual standpoint of the highway traveler.
- Development of guidelines would establish some uniformity and a basis for negotiations for 404 Permits (Clean Water Act, Section 404, regulating waste discharges to Waters of the United States) and habitat replacement with other agencies.
- At the present time with values on existing projects, replanting is expensive and may be non-productive.

RESEARCH OBJECTIVES

1. Identify Section 404 permits and habitat restoration requirements for ADOT projects that are under construction and within the reporting period for completion (3 to 5 years).
2. Assess the progress of the mitigation plantings towards meeting the section 404 permit habitat restoration mitigation requirements.

3. Determine what plant species and 5-year density levels are reasonable and sustainable as related to reference plot conditions in nearby undisturbed habitats.
4. Develop criteria and guidelines for habitat establishment or replacement suitable for ADOT use in mitigation areas required by section 404 permits or for similar planting efforts that may be required by other agencies.

EXPECTED IMPLEMENTATION

At the present time we estimate ADOT spends over several thousand dollars a year for plantings on various projects throughout the state. Evaluations 3 or 4 years after these plantings are being made are beginning to indicate that many of these plantings are being made beyond the naturally sustainable level. The research would provide additional direction to the Department on realistic expectations and commitments.

STATUS OF THE RESEARCH

Project work is on-going with good progress. The bulk of the data collection effort has been accomplished. Project effort will soon shift progressively to data review and evaluation.

TECHNICAL ADVISORY COMMITTEE (TAC)

LeRoy Brady,	Roadside Development, ADOT (Champion);
Representative -	Tonto National Forest;
Vicki Bever	Natural Resource, ADOT;
Michael Daehler -	EEG, ADOT.
Steve Thomas	FHWA
Mathew Moul	ADOT Globe District
Ted Littlefield	ADOT
Zitao Fang	ADOT, Roadside Development
Estomih Kombe	ADOT Project Manager, ATRC

SPR-600, Effectiveness of Microbe Application to Petroleum Spills at Crash Sites

Research Agency:	N Weiss Associates, Inc.	FY Authorization:	2005
Principal Investigator(s):	Norm Weiss	Contract Date:	04-04-2006
Contract Amount:	$15,000	Original Completion Date:	06/2008
Program Budget:	$15,000	Estimated Completion Date:	06/30/2009
Expenditures to date:	$4,500	Is project on schedule?	Yes
Available Amount:	$10,500	ADVANTAGE No.	R060017P
Percent complete Through 6/30/08	50%	Responsible ATRC Staff: (Project Manager)	Tom Kombe

PROBLEM STATEMENT

Hundreds of private and commercial vehicles crash on ADOT roadways yearly, often releasing fuel tank and engine contents onto ADOT property. This may result in soil contamination above regulatory action levels. Runoff from roadways is a nationally recognized storm water quality threat, prompting the California Department of Transportation, for example, to build extensive storm water protection devices. Storm water quality issues at ADOT have been addressed by a consent decree from ADEQ.

Petroleum releases from crashes pose a threat to storm water quality (both natural rain and runoff from fire departments at the crash site) and adjacent soils. One method commonly used to mitigate petroleum-contaminated soils is the application of petroleum-eating microbes to affected areas. ADOT would benefit from a research project, which would begin to answer these questions:

1. What environmental benefit, as measured by standard soil testing, might ADOT expect to obtain from applying a microbe solution to crash site spills as part of our first response to the incident?
2. How much would it cost to equip ADOT response teams to apply microbe solution?

The TRIS database contains 97 abstracts on storm water topics and 2 abstracts on petroleum contaminated soils. The Research in Progress database contains 43 abstracts on storm water topics and 1 on petroleum-contaminated soils. None were found that examined the impact of microbe application on a per-release (per crash, in this case) basis.

RESEARCH OBJECTIVES

1. Assess the effectiveness of microbe application by analyzing treated and untreated samples in a controlled field environment.
2. Determine the cost per response vehicle of preparing teams to apply microbe solution.
3. If applicable, recommend one or more microbe products for use by first response teams.

At a minimum the following tasks will be undertaken:

- Meet with project TAC to review the scope of work and work plan.

- Review the existing literature on microbe application, including asking microbe product manufacturers for input on applicable research.
- Select a research site or sites as necessary.
- Prepare, maintain, sample, and clean up test plots
- Prepare a detailed final report.
- Present results to the Research Council.

EXPECTED IMPLEMENTATIION

The research will provide data that will enable the Agency to decide if it is cost effective to provide crash response teams with microbe application capability. Process owner of the study would be the Safety and Health Section. If implemented, the microbe application process would be owned by local maintenance groups/teams.

STATUS OF THE RESEARCH

The project is ongoing. To allow more time for a thorough data collection effort the duration of the project was extended by 15 months. This followed a no cost extension request from the research team of N Weiss Associates & ASU East.

TECHNICAL ADVISORY COMMITTEE

Travis Qualls	Safety and Health Section, Project Champion.
Courtney Perrier-Bear	ADOT Emergency Response
Steve Thomas	FHWA
Danny Peterson,	ASU Environmental Technology Management
Estomih Kombe -	ATRC Project Manager.

SPR-601, *Cost Evaluation of Cross Border Truck Emissions Testing Using Heavy Duty Remote Sensing (HDRS) Equipment*

Research Agency:	Prophecy Consulting Group, LLC	FY Authorization:	2005
Principal Investigator(s):	Violettee (Vi) Brown	Contract Date:	04-14-2006
Contract Amount:	13,100	Original Completion Date:	06/2007
Program Budget:	$15,000	Estimated Completion Date:	08/31/2008
Expenditures to date:	$12,110	Is project on schedule?	Yes
Available Amount:	$990	ADVANTAGE No.	R060117P
Percent complete Through 6/30/08	95%	Responsible ATRC Staff: (Project Manager)	Tom Kombe

PROBLEM STATEMENT

Trucks at Arizona Land Ports of Entry (LPOE) will soon be required to comply with new emissions standards set by the Environmental Protection Agency (EPA). The Arizona Department of Transportation (ADOT) is now responsible for Truck Safety inspections at the Border - Ports of Entry (LPOE). Trucks are to be detained at the border for these required emissions tests and this will likely occur alongside the current ADOT safety check.

Testing of truck emissions by remote sensing will promote fast tracking of trucks across the border and insure the required emissions testing programs will minimize border congestion. ADOT is in the process of upgrading and remodeling Arizona's LPOE. The design phase of these port improvements would be the ideal time to incorporate this new emission program.

EPA is currently establishing a comprehensive national control program that will regulate heavy-duty vehicle emissions. As part of this program, new emissions standards will begin in vehicle model year 2007. This research will study costs to test truck emissions at border crossings with Remote Sensing Technology. This involves projecting costs to install the Heavy Duty Remote Sensing (HDRS) equipment in the "Fast Lanes" at ADOT ports and also the costs of ongoing testing with HDRS. Developing border truck emissions control-testing strategies that employ remote sensing technology will provide the mitigation of congestion and fast tracking of trucks across the border. In turn this reduces air pollution at these sites from trucks idling for long periods.

PROJECT OBJECTIVES

The study objective is to perform a thorough evaluation of the feasibility and cost implications, initial installation and program costs, for a port of entry truck emissions program utilizing remote sensing technology.

EXPECTED IMPLEMENTATION

The first step will be to review current Remote Sensing technology and the costs to implement and maintain this technology at a LPOE. Using the results of this study ADOT will be able to

make an informed evaluation to determine where this technology would be most useful and if applicable, how soon ADOT would be able to incorporate this into its testing program.

STATUS OF THE RESEARCH

A final report is under review and in queue for publication. A draft final report was submitted and reviewed by the technical committee for comments. This report was subsequently revised and resubmitted for FHWA review/approval and technical editing. With these stages of the review process completed, the report was sent to the ATRC librarian for final format review and publication.

TECHNICAL ADVISORY COMMITTEE

Beverly Chenausky, MPD Air Quality Programs
Colleen Crowninshield, Pima Association of Governments
Peter Hyde, Arizona Department of Environmental Quality (retired)
Ed Stillings, Federal Highway Administration
Jermaine Hannon, Federal Highway Administration
Estomih Kombe, ADOT Project Manager -ATRC

SPR-602*, Sampling and Analyses of Storm Water Runoff on the Red Mountain Freeway - Loop 202*

Research Agency:	Jacobs Civil, Inc./EEC	FY Authorization:	2006
Principal Investigator(s):	John Burton/Todd Ligon	Contract Date:	07/21/2006
Contract Amount:	$39,987	Original Completion Date:	06/30/2008
Program Budget:	$40,000	Estimated Completion Date:	12/31/2008
Expenditures to date:	$33,189	Is project on schedule?	Yes
Available Amount:	$6,796	ADVANTAGE No.	R060218P
Percent complete Through 6/30/08	85%	Responsible ATRC Staff: (Project Manager)	Tom Kombe

PROBLEM STATEMENT

Storm water runoff associated with the Red Mountain Freeway (Loop 202) between Gilbert Rd. and Lindsey Rd discharges into two detention basins and a pump station prior to discharging into the Salt River. This storm water discharge is an important issue because it may carry a wide range of pollutants including nutrients, trash and debris, sediments, heavy metals, pathogens, petroleum hydrocarbons, and synthetic organics such as pesticides. Storm water runoff does not originate from a distinct "point" source (e.g., an industrial discharge pipe), and is often referred to as "non-point" source pollution. Currently, no data is available concerning this type of storm water runoff from Arizona Department of Transportation (ADOT) highways into such waterways. Acquiring this data will assist ADOT in determining appropriate best management practices (BMPs) to implement and how best to protect surface water quality.

The benefits from this study will give ADOT baseline data in determining what contaminants, if any, are entering the Salt River. The results of this data will be used to determine if BMPs are sufficient to protect surface water quality and to adjust BMPs as necessary.

RESEARCH OBJECTIVES

The objective of this monitoring program is to characterize the storm water entering each detention basin and the storm water entering the Salt River. Acquiring this data will allow ADOT to evaluate the effectiveness of its BMPs being implemented along this portion of the Loop 202.

EXPECTED IMPLEMENTATION

ADOT's Central Maintenance group working with ADOT Roadside Development section will be responsible for reviewing implementation recommendations from this project.

STATUS OF THE RESEARCH

This project is on-going, at the final report preparation stage. Following the completion of data collection and sample evaluation and analysis the research team met and presented preliminary findings to the TAC for feedback. The team was asked to proceed to prepare and submit a draft final report to the TAC for a formal review. It is expected that this draft report will be ready by the end of August 2008.

Environment

TECHNICAL ADVISORY COMMITTEE

LeRoy Brady, ADOT Roadside Development - Champion
Colleen Kelly, Eco Plan Associates, Inc.
Jeff Beimer, ADOT Roadway Drainage Section
Steve Thomas, FHWA
Zitao Fang, ADOT Roadside Development

SPR-603*, Evaluation of Measures to Minimize Wildlife-Vehicle Collisions & Maintain Wildlife Permeability – Kohls Ranch Section, State Route 260*

Research Agency:	Arizona Game and Fish Department	FY Authorization:	2006
Principal Investigator(s):	Ray Schweinsburg	Contract Date:	11-10-2005
Contract Amount:	$166,313	Original Completion Date:	06/30/2008
Program Budget:	$166,313	Estimated Completion Date:	03/31/2009
Expenditures to date:	$147,033	Is project on schedule?	Yes
Available Amount:	$19,280	ADVANTAGE No.	R060318P
Percent complete Through 6/30/08	80%	Responsible ATRC Staff: (Project Manager)	Tom Kombe

PROBLEM STATEMENT

Under Phase I (2004-2004) of the SR 260 research project we recorded 4,001 animals with video camera systems at the 1st 2 underpasses (UP), comparing use (e.g., 68% passage rate) and behavioral response. Based on this data, ADOT made major design changes to the UP on the Kohls Ranch (KR) Section. We accrued 101,500 fixes from 33 elk fitted with GPS satellite tracking collars, and identified 3,057 highway crossings and assessed permeability. This data was used to determine the extent of elk-proof fencing needed to intercept and funnel elk to UP, maximizing UP effectiveness. In the KR Section, adding fencing to 25% of the section is projected to intercept 60% of the elk crossings. We compared GPS crossings to nearly 500 wildlife-vehicle collisions (WVC) from 1994-2004, and compared collisions before and after highway reconstruction. Under Phase II (2004-2006), we've fitted 29 elk and 7 whitetail deer with GPS collars. Video surveillance has been ongoing at 4 UP on the Christopher Creek (CC) Section since 2004, with 1,158 animals recorded; passage rates have been low (23%). With additional UP video assessment, we will be able to conduct multivariate analysis of factors affecting wildlife use and UP effectiveness and assess long-term changes in usage. This project will provide long-term data on wildlife use of UP and permeability, as well as assess the effectiveness of adaptive management changes made on the KR Section.

In summary, project benefits include - 1) Highway safety - WVC reduction, 2) enhanced long-term research and insights for future application, 3) increased effectiveness of wildlife measures, 4) enhanced standing for ADOT on liability issues involving WVC, 5) enhanced decision making on future highway applications, 6) continued commitment to sound project management principals, 7) national leadership in innovative application of UP

RESEARCH OBJECTIVES

1) Analyze collisions to assess effectiveness of UP and fencing in reducing WVC, 2) install video camera system to assess wildlife use of the new KR Section UP, 3) fit 6 elk with GPS collars on the KR Section, and track those collared in Phase II to assess elk permeability after reconstruction, 4) continue to monitor the 6 UP with video systems already in place to yield long-term data, and 5) continue to work closely with ADOT managers to improve the effectiveness of wildlife measures.

EXPECTED IMPLEMENTATION

The results of our management-oriented research will support ongoing adaptive management with ADOT to develop and implement effective UP structures and determine fencing needs. Insights from this research will be used to develop guidelines for future underpasses.

STATUS OF THE RESEARCH

The project is ongoing with good progress. In the 30 months of the project effort animal monitoring activities have continued without any major setbacks. If the last set of GPS collars drops of as expected this fall will conclude the data collection phase of the project.

TECHNICAL ADVISORY COMMITTEE

Bruce Eilerts	ADOT Natural Resources, Champion
Mike Ross	Tonto National Forest
Doug Brown	AZ Dept. of Administration
Norris Dodd	AZ Game & Fish Dept., Research Leader
Ray Schweinsburg	AZ Game & Fish Dept
Steve Thomas	Federal Highway Administration
Terry Brennan	Tonto National Forest
Melissa Maiefski	ADOT Environmental & Enhancement Group
Tom Kombe	ADOT Research Project Manager, ATRC

SPR-619*, Study of Antelope Movements North of Interstate 40 in Arizona*

Research Agency:	Arizona Game and Fish Department	FY Authorization:	2006
Principal Investigator(s):	Norris Dodd	Contract Date:	11/24/2006
Contract Amount:	$197,000	Sched. Completion Date:	06/30/2009
Program Budget:	$197,000	Est. Completion Date:	06/30/2009
Expenditures to date:	$52,656	On schedule?	Yes
Available Amount:	$144,344	ADVANTAGE No.	R061918P
Percent complete Through 6/30/08	50%	Responsible ATRC Staff: (Project Manager)	Tom Kombe

PROBLEM STATEMENT

Historically, as many as 4,500 pronghorn antelope moved freely throughout northern Arizona in response to climatic variations. These meta-populations were restricted in movement only by a few natural barriers. The landscape movements available to historic pronghorn populations allowed for survival through catastrophic climatic events, such as heavy snow or prolonged drought, or to take advantage of favorable conditions within a portion of their range. Over the last century, however, roads and fences were constructed in northern Arizona and throughout the west to meet the needs of a growing human population. The development of roads and fences created ever-increasing barriers to the once free-ranging movements of pronghorn meta-populations. Many highways across the west are constructed in broad, open terrain that pronghorn need to sustain a viable population. Subsequently, pronghorn habitat became fragmented across northern Arizona and the west. As a result, pronghorn populations were isolated, movements restricted, and they suffered major population declines. The decline of the once vast pronghorn populations of northern Arizona is a major concern to wildlife managers. Arizona Game and Fish Department (AGFD) studies continue to show pronghorn antelope populations confined by barriers of fencing and roadways. AGFD believes the loss of historic connectivity (genetic and collective population memory loss) that provided access to habitats capable of supporting populations during catastrophic climatic events are contributors to stagnation of Arizona's pronghorn populations.

Research studies throughout Arizona and throughout the United States that have evaluated highway crossings for large mammals mostly assessed the effectiveness of underpasses or culverts, which pronghorn are known to avoid because of their unique behavior for detecting and avoiding danger. Additionally, many of the crossings are not constructed within occupied pronghorn habitat. In order to provide wildlife managers and highway design engineers throughout the western United States with the information needed to ensure unobstructed movement of pronghorn across wide, high-speed freeways; research specifically designed with the habitat and biological requirements of pronghorn is required. Specific research is needed to determine how to reconnect pronghorn meta-populations that have been fragmented by highways. Because pronghorn use acute eyesight to detect danger and fleetness to escape it, they prefer open areas with little to no visual or physical obstructions. Thus, it is expected that an overpass that allows pronghorn unobstructed views is the most likely type of structure that pronghorn would use to cross a highway. However, this has never been tested, leaving highway

engineers and wildlife managers without precise data on an effective highway design or wildlife crossing structure for facilitating pronghorn movement. The proposed US 89 Antelope Hills – Junction US 160 project provides a unique opportunity to study pronghorn movements, and recommend design and placement of pronghorn crossing structures within occupied habitat that may support unrestricted pronghorn movement. This research could provide the information required by highway engineers throughout the western United States to address concerns of highway impacts to fragile pronghorn populations.

RESEARCH OBJECTIVES

Specific research objectives include:

1. Assess pronghorn movement patterns and distribution relative to US 89 and determine permeability across the highway corridor
2. Investigate the relationships of pronghorn highway crossing and distribution patterns to vehicular traffic volume
3. Assess the influence of fencing on pronghorn highway crossing patterns and permeability
4. Investigate wildlife-vehicle collision patterns along US 89
5. Assess the degree to which US 89 and other northern Arizona highways have affected gene flow and genetic diversity among pronghorn populations
6. Develop recommendations to enhance pronghorn highway permeability.

EXPECTED IMPLEMENTATION

The Arizona Game and Fish Department will conduct both aspects of the research designs. ADOT management will determine whether, and if so, where, to construct a crossing structure, associated drift fencing, and roadway modifications.

STATUS OF THE RESEARCH

The Arizona Game and Fish Department continues with the execution of this project with good progress.

TECHNICAL ADVISORY COMMITTEE (TAC)

John Harper & Steve Moore, ADOT Flagstaff District
Justin White, ADOT EEG Flagstaff
Steve Thomas, FHWA
Steve Michelson, National Park Service
Cary Thompson, National Forest Service
Ray Schweinsburg, Arizona Game and Fish Department
Pamela Kyselka, Navajo Fish and Wildlife

SPR-624, *Hazardous Materials Transportation in Arizona*

Research Agency:	HDR, Inc.	FY Authorization:	2007
Principal Investigator(s):	Kelly W. Kading	Contract Date:	06/30/2008
Contract Amount:	$49,954.00	Sched. Completion Date:	06/30/2009
Program Budget:	$53,000.00	Est. Completion Date:	06/30/2009
Expenditures to date:	$0	On schedule?	Y
Available Amount:	$53,000.00	ADVANTAGE No.	R062419P
Percent complete Through 6/30/08	0%	Responsible ATRC Staff: (Project Manager)	Tom Kombe

PROBLEM STATEMENT

Currently, hazardous materials routing in Arizona is limited to the avoidance of three locations: the I-10 deck park tunnel, the U.S. 60/S.R. 101 loop ramp, and the S.R. 202 Salt River bridge. As Arizona's population grows and highway infrastructure increases, the issue of routing needs to be re-assessed. In the last three months alone, ADOT has been questioned about possible hazardous materials routes for the proposed Tucson tunnel and the South Mountain freeway. In order to address issues related to hazardous materials routing, ADOT needs to acquire current data on hazardous materials transport and a methodology for determining alternate routes. Hazardous materials transportation and bypass routing is of interest to the Environmental and Enhancement, Transportation Services, and Traffic Groups in ADOT. Current information on hazardous materials transport will also be of use to planners within Department of Public Safety, Division of Emergency Management and various first responder agencies. The results of a hazardous materials survey and a methodology for determining bypass routes will be useful for both safety and decision-making purposes.

RESEARCH OBJECTIVES

The first objective is to assess the types and amounts of hazardous materials currently transported on Arizona's State and U.S. Highways. (The Interstates and U.S. 60 are excluded because they are part of a similar study by the Arizona Emergency Response Commission.) Placard surveys will be conducted in locations with an annual average daily traffic count >10,000 and a truck count >15% (see attachment). The second objective is the derivation of a suggested methodology for determining hazardous materials bypass routes. This result should be general so that it can be re-applied due to changes in population, highway infrastructure or the nature of hazardous material transport in the state.

EXPECTED IMPLEMENTATION

The data on hazardous materials transport on Arizona's Highways will be published and available for use by ADOT and other agencies. The method for determining bypass routes will be available for implementation by ADOT personnel as the need arises.

STATUS OF THE RESEARCH

The project is now on-going. Notice to proceed was made June 30th, 2008 following consultations between the research team and the project technical advisory committee.

Environment

TECHNICAL ADVISORY COMMITTEE (TAC)

- Angela Roach, Environmental Planning, (Champion)
- Travis Qualls, ADOT Health and Safety
- Ed Green, Environmental Planning
- Bill Tait, ADOT Emergency Manager
- Mike Manthey, Traffic Group
- Reed Henry, Traffic Group
- Steve Thomas, Federal Highway Administration
- Mark Howard, Arizona Emergency Response Commission
- Tom Kombe, ATRC Project Manager

SPR-626, *State Route 64 Wildlife Accident Reduction Study Monitoring*

Research Agency:	Arizona Game and Fish Department	FY Authorization:	2007
Principal Investigator(s):	Ray Schweinsburg	Contract Date:	07/27/2007
Contract Amount:	$195,600	Sched. Completion Date:	06/30/2010
Program Budget:	$195,600	Est. Completion Date:	06/30/2010
Expenditures to date:	$96,150	On schedule?	Yes
Available Amount:	$99,449	ADVANTAGE No.	R062619P
Percent complete Through 6/30/08	40%	Responsible ATRC Staff: (Project Manager)	Tom Kombe

PROBLEM STATEMENT

Highways cause direct mortality to wildlife from wildlife-vehicle collisions (WVC) and create barriers to crossing animals. With increasing motorist use of Arizona's rural highways, these impacts are intensifying, as are safety and property damage concerns with WVC. For State Route (SR) 64, the main highway access to the Grand Canyon, a proactive Wildlife Accident Reduction Study was completed in 2006. This study addressed the high incidence of WVC along 50 miles of this high traffic volume highway; WVC accounted for 48% of all accidents from 1998-2003. This purpose of the study was to identify and evaluate alternatives to reduce WVC (and enhance permeability) for incorporation into a feasibility study being developed for the reconstruction of SR 64; this study identified numerous sites for future passage structures. However, this report also identified interim monitoring needs to provide information or address questions in support of the feasibility study and future reconstruction.

RESEARCH OBJECTIVES

To address the monitoring needs in the SR 64 Wildlife Accident Reduction Study, the research objectives of this proposed project include:

1. Assess elk, mule deer, and pronghorn movements, highway crossing patterns, and distribution relative to SR 64 and determine permeability across the highway corridor,
2. Investigate the relationships of elk, mule deer, and pronghorn highway crossing and distribution patterns to vehicular traffic volume along SR 64,
3. Assess the degree to which the existing Cataract Canyon Bridge is currently used by wildlife for below-grade passage,
4. Investigate wildlife-vehicle collision patterns along SR 64 and relationships to elk, mule deer, and pronghorn movement and highway crossing patterns,
5. Assess the degree to which SR 64 and other northern Arizona highways have affected gene flow and genetic diversity among pronghorn populations (NOTE: this is an OPTIONAL objective dependent on additional funding), and

6. Develop recommendations to enhance elk, mule deer and pronghorn highway permeability though the application of wildlife passage structures and ungulate-proof fencing.

EXPECTED IMPLEMENTATION

The results will be used to refine plans for reconstruction of SR 64 to meet wildlife passage and permeability as part of the feasibility study being conducted, as well as be incorporated into scientific journal manuscripts and compliment wildlife-highway research collected elsewhere in Arizona.

STATUS OF THE RESEARCH

The project is on-going. The Arizona Game and Fish Department leads this project effort under a Joint Project Agreement with ADOT.

TECHNICAL ADVISORY COMMITTEE (TAC)

- John Harper – Flagstaff District (Sponsor)
- Justin White – Environmental Planning, Flagstaff (Champion)
- Ray Schweinsburg – Arizona Game and Fish Dept.
- Jeff Waters – Forest Service, Kaibab NF
- Steve Mitchelson – National Park Service (tentative)
- Steve Thomas – FHWA
- Tom Kombe – ATRC Project Manager

SPR-647, *Elk Movements Associated with a High-Traffic Highway: Interstate-17*

Research Agency:	Arizona Game and Fish Department	FY Authorization:	2008
Principal Investigator(s):	Ray Schweinsburg	Contract Date:	02/04/2008
Contract Amount:	$250,000	Sched. Completion Date:	06/30/2010
Program Budget:	$250,000	Est. Completion Date:	06/30/2010
Expenditures to date:	$0	On schedule?	Y
Available Amount:	$250,000	ADVANTAGE No.	R064720P
Percent complete Through 6/30/08	0%	Responsible ATRC Staff: (Project Manager)	Tom Kombe

PROBLEM STATEMENT

Wildlife-vehicle collisions (WVC) cause tremendous property damage, human injuries and deaths, and substantial mortality to wildlife. Highways present barriers to the free movement of wildlife from reduced permeability and can fragment and isolate populations. Insights gained from ATRC-funded research along State Route (SR) 260 (Dodd et al. 2007) illustrated the impact of highway reconstruction on WVC and elk permeability, as well as the benefit (to safety, wildlife, and economics) of mitigation measures such as underpasses and fencing to reduce WVC and promote elk permeability. This study also shed light on the relationships to vehicular traffic volume to wildlife passage. Traffic on SR 260 (< 9,000 AADT) only occasionally posed a barrier to elk during peak volume periods. A small proportion of the elk (22%) crossed the highway frequently (>0.4 crossings/day), yet accounted for 87% of the collisions with vehicles.

WVC along Interstate-17 (I-17) present a significant safety and liability concern, particularly those involving elk between MP 310-325 where WVC constitute the single greatest cause of crashes. ADOT funded an ongoing pilot study assessment of elk movements and permeability here in 2005. Preliminary results of this study show that I-17 presents a significant barrier to wildlife passage compared to SR 260, owing to its high traffic volume (>17,500 AADT); we suspect that like SR 260, relatively few elk account for most accidents, though our small sample size has yet to include such elk. The potential exists in working with the ADOT Flagstaff District to address the incidence of WVC through fencing that will link existing structures (e.g., bridges and large box culverts) to create wildlife passages, which may also improve wildlife permeability as done on SR 260. Research here will complement that done on SR 260 and provide valuable insights into the impact of high traffic volumes on wildlife (heretofore only theoretical) and ability to mitigate highway impact under such traffic volumes.

RESEARCH OBJECTIVES

This project will continue and expand upon a pilot elk movements study ongoing since 2005. Objectives include:

1) Assess elk movements, distribution, and crossing patterns, and assess elk permeability by GPS telemetry,
2) Investigate the relationships of elk crossing and distribution patterns to traffic volume (using a newly installed traffic counter),

3) Validate and refine our model assessing the influence of various environmental parameters developed for SR 260,
4) Investigate wildlife-vehicle collision patterns, and
5) Develop recommendations for the retrofitting of existing and reconstruction of new wildlife passage structures and other mitigations to reduce WVC and promote permeability

EXPECTED IMPLEMENTATION

The results of this project will be used by the ADOT Flagstaff District to develop short-term strategies to reduce WVC and promote wildlife permeability along I-17 through fencing of high incidence elk crossing zones and collision hotspots. The results will also be integrated into design concept planning for future reconstruction.

STATUS OF THE RESEARCH

The project is on-going, effective February 4th, 2008.

TECHNICAL ADVISORY COMMITTEE (TAC)

Todd Williams, ADOT Environmental Services, Project Champion
John Harper, ADOT Flagstaff District, Project Sponsor
Justin White, Environmental Planning – Flagstaff
Sreelatha Gajula, Traffic Group
Chuck Howe, ADOT Flagstaff District
Steve Thomas; Federal Highway Administration
Bruce Eilerts, ADOT Natural Resources
Cindy Eiserman, ADOT Risk Management
Ray Schweinsburg, AGFD Research Branch
Chris Fetzer, Northern Arizona Council of Governments (NACOG)
Henry Provencio, US Forest Service
Estomih Kombe, ATRC Project Manager

SPR-650*, Predicting Desert Tortoise (Gopherus agassizzii) Habitat and Identifying Movement Patterns within the Proposed Highway 95 Realignment*

Research Agency:	Arizona Game and Fish Department	FY Authorization:	2008
Principal Investigator(s):	Ray Schweinsburg	Contract Date:	02/04/2008
Contract Amount:	$346,000.00	Sched. Completion Date:	09/30/2010
Program Budget:	$346,000.00	Est. Completion Date:	09/30/2010
Expenditures to date:	$35,732.94	On schedule?	Y
Available Amount:	$310,267.06	ADVANTAGE No.	R065020P
Percent complete Through 6/30/08	20%	Responsible ATRC Staff: (Project Manager)	Tom Kombe

PROBLEM STATEMENT

State Route 95 has been proposed for expansion through one of the important desert tortoise Key Habitat Areas (KHA) within the State, and could irreversibly fragment the area if not properly placed and designed. Preliminary work within the KHA suggests a correlation between tortoise activity and Aridisol soil types, and shows promise as a tool to assist in proper placement of the new highway. Without this tool biologists lack the ability to predict and quantify important tortoise areas, and therefore fully assess the threat from the proposed Highway 95 project. Once proper placement of the alignment is determined, specific crossing structures to facilitate safe tortoise passage is needed. Two general variables are critical to the success of wildlife crossings: location and design. To determine the number and location of crossing structures, tortoise movement patterns must be understood prior to highway design. Finally, the proper type of crossing structures must be incorporated at each previously identified location so as to ensure an effective wildlife mitigation package for this highway project.

RESEARCH OBJECTIVES

1. Develop and validate a soil-based predictive model for desert tortoise occupancy to quantify potential impacts from proposed SR 95, and to recommend specific placement of the alignment
2. Using GPS tracking devices, identify areas along the proposed SR 95 realignment for the potential placement of underpass structures to facilitate safe tortoise passage
3. Determine effectiveness of existing crossing structures and associated fencing constructed to facilitate the crossing of desert tortoises on Highway 93, and;
4. Provide insight (management recommendations) for improvement and assess feasibility of similar mitigation for proposed Highway 95 project in the Black Mountain area.

EXPECTED IMPLEMENTATION

This project will help ADOT with compliance issues relevant to this sensitive species. Results for this project will allow for roadway designers to place the new highway 95 realignment in an area that has the least impact on desert tortoises, thereby reducing any possible delays caused by litigation. In addition, results from this study will allow for the most efficient placement of

roadway underpasses for desert tortoises, potentially saving dollars from arbitrarily placing structures where they are not needed.

STATUS OF THE RESEARCH

The project is on-going, effective February 4th, 2008.

TECHNICAL ADVISORY COMMITTEE (TAC)

Julie Alpert, Environmental Coordinator Kingman District (Champion)
Julie Alpert & Victor Yang, Manager Roadway Predesign (Sponsors)
Michael Ingraldi, Game and Fish Dept.
Bruce Eilerts, ADOT Natural Resources
Ray Schweinsburg, Game and Fish Department
John Reid, BLM – Kingman
Darlene Dyer, Environmental Planning - Flagstaff
Steve Thomas, Federal Highway Administration
Estomih Kombe, ATRC Project Manager

SPR-659, *Genetic Variation of Pronghorn across US Highway 89 and State Route 64*

Research Agency:	Northern Arizona University	FY Authorization:	2008
Principal Investigator(s):	Dr. Tad C. Theimer	Contract Date:	05/07/2008
Contract Amount:	$15,000	Sched. Completion Date:	08/31/2009
Program Budget:	$15,000	Est. Completion Date:	08/31/2009
Expenditures to date:	$0	On schedule?	Y
Available Amount:	$15,000	ADVANTAGE No.	R065920P
Percent complete Through 6/30/08	0%	Responsible ATRC Staff: (Project Manager)	Tom Kombe

PROBLEM STATEMENT

Based on behavioral observations, the barrier effect from highways is likely greater on pronghorn than most other large mammal species, including bighorn. During extensive VHF-telemetry studies in northern Arizona over several years, Richard Ockenfels and colleagues with the Arizona Game and Fish Department never documented a successful pronghorn crossing of a paved and fenced highway. Relatively recent population bottlenecks in northern Arizona combined with the separation caused by roads and associated right-of-way fencing may indicate an even more dramatic level of isolation than those identified by Epps and colleagues for bighorn in 2005. Genetic markers to determine the effect of highways on pronghorn genetics have already been developed, but have not been used in this context.

Given the degree to which highways are known to block pronghorn movements, the depressed nature of current pronghorn populations in northern Arizona and the fact that U.S. Highway 89 and State Route 64 will be reconstructed in the future to accommodate increasing volumes of traffic, the challenge before us is to determine if and how pronghorn populations in northern Arizona can be reconnected to maintain population viability into the future. Information gained from this research may help justify the implementation of such passage structures to accommodate pronghorn movement.

RESEARCH OBJECTIVES

The objective of this study is to determine whether genetic samples collected from pronghorn on opposite sides of US89 and SR64 indicate greater genetic difference than expected if the highway were not acting as a barrier to movement. Specific tasks will include;

1) Extract DNA from pronghorn samples collected by AZGFD personnel along US 89 and SR 64.
2) Analyze those samples using microsatellite markers to determine whether populations on opposite sides of the highway are more genetically distinct than expected if the highway were not acting as a barrier to movement.
3) To prepare annual and final written reports interpreting the results of our genetic analysis and whether they support the hypothesis that highways have resulted in genetic differentiation

Environment

EXPECTED IMPLEMENTATION

Information gained from this project will document the potential for highways to genetically isolate pronghorn populations. These data will inform decisions about the feasibility and importance of mitigating highway upgrades via measures such as population augmentation or creating crossing opportunities for pronghorn across Arizona roadways.

STATUS OF THE RESEARCH

The research project is ongoing, effective May 7th, 2008.

TECHNICAL ADVISORY COMMITTEE (TAC)

Justin White, Biologist – Environmental Services Flagstaff (Champion)
John Harper, District Engineer – Flagstaff (Sponsor)
Chuck Howe, Environmental Coordinator – Flagstaff District
Cary Thompson, National Forest Service
Steve Monroe, Flagstaff District
Pamela Kyselka, Navajo Fish and Wildlife
Steve Thomas, Federal Highway Administration
Estomih Kombe, ATRC Project Manager

SPR-677*, Evaluation of Measures to Promote Desert Bighorn Sheep Highway Permeability: US Highway 93*

Research Agency:	Pending	FY Authorization:	2009
Principal Investigator(s):	Pending	Contract Date:	Pending
Contract Amount:	Pending	Sched. Completion Date:	Pending
Program Budget:	$185,000	Est. Completion Date:	Pending
Expenditures to date:	$0	On schedule?	N/A
Available Amount:	$185,000	ADVANTAGE No.	R067721P
Percent complete Through 6/30/08	0%	Responsible ATRC Staff: (Project Manager)	Tom Kombe

PROBLEM STATEMENT

One of the most pervasive impacts of highways on wildlife is the barrier effect that results in diminished habitat connectivity and permeability. Highways block animal movements between seasonal ranges or other vital habitats, fragment habitats and populations, reduce genetic interchange, and disrupt viable population processes. Recent research on desert bighorn sheep movements and crossing patterns adjacent to US 93 point to the barrier created by this highway through the largest bighorn sheep populations in Arizona, as well as the impact of bighorn-vehicle collisions. US 93 (MP 2-17) is planned for reconstruction from a 2-lane to a 4-lane divided highway beginning in either late 2008 or early 2009. Concerns exist that this reconstruction could further fragment bighorn habitat and contribute to increased bighorn-vehicle collisions. Wildlife passage structures have shown benefit in promoting passage for a variety of wildlife species, have reduced the incidence of wildlife-vehicle collisions, and yielded substantial economic benefit. As such, the Arizona Department of Transportation (ADOT) plans to construct 3 wildlife overpasses (the first in the state) with fencing linking the structures to promote bighorn permeability across the US 93 corridor. This represents a tremendous commitment on the part of ADOT and warrants thorough evaluation to assess the efficacy of overpasses in promoting permeability, particularly since few overpasses exist in North America. To assess the efficacy of the planned US 93 wildlife overpasses in promoting permeability, it is necessary to compute bighorn passage rates as an objective metric, comparing passage rates before (phase I; 2 years, before and during construction) and after construction of the planned passage structures is completed (phase II; 2 years, future funding). This funding request covers phase I. It is anticipated that once completed, wildlife use of the overpasses will be monitored by video surveillance.

RESEARCH OBJECTIVES

This proposed research project will add greatly to our understanding of desert bighorn sheep-highway relationships and the effectiveness of planned overpasses to promote permeability. Specific objectives include assessing:

(1) Desert bighorn sheep movement and highway crossing patterns, and calculate permeability across the highway corridor before and after overpasses are constructed;
(2) Spatial and temporal relationships of bighorn highway crossing patterns to vehicular traffic volume;
(3) Wildlife-vehicle collision patterns;

(4) Impact of highway construction activities on bighorn sheep; and
(5) Wildlife use of wildlife overpasses and jump-outs.

EXPECTED IMPLEMENTATION

The results of this project will validate the benefit of overpasses in promoting bighorn permeability, and will be used by highway and wildlife departments across North America to address wildlife permeability. The results and insights will also be integrated into design concept planning for future highway reconstruction as well as new construction.

STATUS OF THE RESEARCH

Pending

TECHNICAL ADVISORY COMMITTEE (TAC)

Julie Alpert, Environmental Coordinator Kingman District (Champion)
Michael Kondelis, District Engineer - Kingman (Sponsor)
Ray Schweinsburg, Game and Fish Dept.
Bruce Eilerts, ADOT Office of Environmental Services – Natural Resources
Steve Thomas, Federal Highway Administration
Rep, BLM
Rep, Forest Service
Estomih Kombe, ATRC Project Manager

Intelligent Transportation Systems (ITS) – PROJECTS

SPR-604, *Real-time Adaptive Ramp Metering: Phase 2 – Implementation and Enhancement*

Research Agency:	University of Arizona	FY Authorization:	2006
Principal Investigator(s):	Dr. Pitu Mirchandani	Contract Date:	01/19/07
Contract Amount:	$200,000	Sched. Completion Date:	12/31/08
Program Budget:	$200,000	Est. Completion Date:	12/31/08
Expenditures to date:	$98,994	On schedule?	Yes
Available Amount:	$101,006	ADVANTAGE No.	R0604 18P
Percent complete Through 6/30/08	50%	Responsible ATRC Staff: (Project Manager)	Frank Darmiento

PROBLEM STATEMENT

ADOT's Freeway Management System (FMS) is designed for "smart" ramp metering, considering the ramp impacts on mainline traffic flow, but real-time traffic-adaptive metering has never effectively been deployed. New FMS upgrades will allow full utilization of control strategies, such as University of Arizona's MILOS program, to smooth traffic flows and improve regional operations. Phase 1, the recent SPR 595 research, was the "proof of concept" for integration of existing ADOT systems with new traffic management programs and firmware, so that the optimum metering rates, as determined by MILOS, can be downloaded to the ramps.

This new Phase 2 project will implement MILOS, evaluate its operation, and identify required operational enhancements. It will deploy MILOS as an operational prototype system that can be field tested by ADOT operations staff to more efficiently manage freeway corridor operations.

RESEARCH OBJECTIVES

The new Phase 2 effort will evaluate the performance of MILOS in field operational conditions. Initially, MILOS will be operated in "shadow mode" to observe functionality, and to identify strengths and weaknesses as well as any needed enhancements. Solutions will be developed to address needs and deficiencies, tested using simulation, and implemented in the operational system. The program will then be run on-line to develop data to compare and evaluate both the "MILOS-ON" and "MILOS-OFF" performance.

EXPECTED IMPLEMENTATION:

This research, for the first time, would fully utilize technologies and capabilities that are already available in the existing ADOT ramp metering system, which is available for "smart" ramp metering, but was never configured to do so. A new traffic-adaptive ramp metering system will be incorporated into ADOT's FMS operations.

Implementation could begin to occur within two years on a corridor-priority basis. Significant benefits to the regional freeway system would include a decrease in congestion, and increased throughput on freeway networks, as well as improved efficiency and safety, reductions in resource consumption, and improved air quality.

STATUS OF THE RESEARCH

The 604 project was initiated with a kickoff TAC meeting in February 2007. Initial program tasks included simulation modeling, integration testing, and algorithm development, which are continuing to be refined. Additionally, the subsequent bench testing phase is ongoing to establish the basis for field testing of MILOS, which is targeted for the fall of 2008.

A no-cost schedule extension was approved for this project, through 31 December 2008.

TECHNICAL ADVISORY COMMITTEE (TAC)

S. Nodes (sponsor)	Transportation Technology Group / TOC Manager
D. Bingham, G. Jonas, L.Warnick	Transportation Technology Group – TOC
T. Wolfe	Phoenix Maintenance District
S. Orrahood	Traffic Engineering Group
J. McGuirk	Phoenix Maintenance District
S. Joshua	Maricopa Association of Governments (MAG)
F. Saleem	Maricopa County DOT
J. Decker, C. Warren	City of Tempe
J. Siefert	City of Phoenix
A. Hansen	Federal Highway Administration

SPR-627, State-of-the-Art Evaluation of Traffic Detection and Monitoring Systems

Research Agency:	Texas Transportation Institute	FY Authorization:	2007
Principal Investigator(s):	Dan Middleton	Contract Date:	02/12/07
Contract Amount:		Sched. Completion Date:	09/30/09
Program Budget:	$200,000	Est. Completion Date:	09/30/10
Expenditures to date:	$66,914	On schedule?	No
Available Amount:	$133,086	ADVANTAGE No.	R0627 19P
Percent complete Through 6/30/08	50%	Responsible ATRC Staff: (Project Manager)	Frank Darmiento

PROBLEM STATEMENT

Accurate, complete and timely traffic data is critical to the effective management of the State's highway system. Limitations in current traffic monitoring abilities are an ongoing problem for ADOT, and for its customers as well, in both urban and rural areas. MAG, PAG, and ADOT's Multimodal Planning Division depend on detector data for planning purposes. If this data is not accurate, it may cost the state millions of dollars in federal funding. ADOT now spends about $50,000 per site to install detection, and another $1,000 per year to maintain each site. For 250 centerline miles of freeway, ADOT will invest roughly $25M to install traffic sensors and another $10M to maintain them over the 20-year life of the Regional Transportation Program.

RESEARCH OBJECTIVES

A number of technologies exist for detecting vehicles and determining volume, occupancy, and speed. Current technologies include buried loops, micro-loops, passive acoustic detectors, radar, and video detection. All have been used with varying degrees of success in different states.

This research will evaluate different non-intrusive technologies for traffic surveillance. The project will perform a state-of-the practice review of current technologies with the potential to more accurately monitor traffic volume, occupancy, and speed. This review will also include a literature search of recent and current research. The results will be specific recommendations in technology, software, and communications, and a conceptual testbed design, that conform to the basic ADOT goals, design constraints, data requirements, and budget limitations.

On this basis, the project will then develop the detailed design of a field test environment and evaluation program. Upon acceptance of the design, this project will support the establishment of the field evaluation testbed site, by others. Based upon this study's earlier recommendations, the most promising detector types will be deployed for an initial field-testing period, and the evaluation results will be documented in an ATRC final report.

EXPECTED IMPLEMENTATION

ADOT's entire freeway management operations mission in the major metropolitan areas is hampered by poor or missing data. The core data goals are impacted, including valid traveler information for the public, as well as valid traffic data for ADOT planning, for FHWA, and for partner agencies such as PAG, MAG, and AZTech. Effective new solutions for urban freeway management systems also will transfer to rural highway operations across the state. The results

of this research and evaluation program will provide the basis for future planning and design of ADOT's Freeway Management System (FMS). Local corridor testing of field-evaluated systems is a likely initial result of the study. If the tests are successful, then upgrades to FMS segments and to ADOT's rural ITI could follow, as funding allows.

STATUS OF THE RESEARCH

This project was scoped in three phases; the Texas Transportation Institute (TTI) has completed the initial two phases. These included a detection state of the practice study, a conceptual testbed site design, traffic-detector evaluation recommendations, and a site-specific design, evolving from the conceptual phase. By late 2007, TTI had completed the transition from the concept to a full testbed facility design.

After resolving issues regarding the facility budget, efforts are underway to complete a full design package, and to formally program facility funding from several ADOT partner sections.

As the detailed design nears completion, development will begin on the proposed test site on heavily congested Interstate 10 through downtown Phoenix. The planned evaluation of several candidate detector systems, for approximately 15 months, may utilize the resources of both TTI and a local consulting team.

TECHNICAL ADVISORY COMMITTEE (TAC)

S. Nodes (sponsor/champion)	ADOT Technology Group / Traffic Operations Center
R.Gish, G. Jonas, F. Yasmin, L. Warnick, J. Lovell	ADOT Transportation Technology Group
T. Wolfe (co-champion), J. McGuirk, C. McClatchey	Phoenix Maintenance District
G. A. Girgis	ADOT Vision – ITS/FMS Construction
M. Manthey, D. Duffy	ADOT Traffic Engineering Group
J. Garrison, D. Eberline	ADOT Multimodal Planning Division
W. Zhang, L. Luo	Maricopa Association of Governments (MAG)
P. Casertano	Pima Association of Governments (PAG)
B. Dressel	City of Scottsdale
T. Kelley	Pima County DOT
J. Decker	City of Tempe
Cdr. T. Woodward	Arizona Department of Public Safety
A. Hansen	Federal Highway Administration

SPR-634, *A Platform for Evaluating Emergency Evacuation Strategies*

Research Agency:	University of Arizona	FY Authorization:	2007
Principal Investigator(s):	Drs Yi-Chang Chiu & Pitu Mirchandani	Contract Date:	03/09/07
Contract Amount:	Pending	Sched. Completion Date:	09/30/08
Program Budget:	$100,000	Est. Completion Date:	09/30/08
Expenditures to date:	$82,886	On schedule?	Yes
Available Amount:	$17,114	ADVANTAGE No.	R0634 19P
Percent complete Through 6/30/08	83%	Responsible ATRC Staff: (Project Manager)	Frank Darmiento

PROBLEM STATEMENT

The importance of transportation resources in emergency planning and response was proven in late 2005, with Hurricanes Katrina and Rita. During these events, deficiencies in the planning and execution of evacuation strategies were apparent. The real scenarios that occurred were far from the anticipated potential scenarios. Moreover, it is clear that existing public agency tools are limited in how well they can support real-time evacuation management.

A more comprehensive resource is needed that includes network and transportation services data and simulation tools to evaluate evacuation strategies and evacuee response. It would be a tool for emergency management personnel to better plan and execute evacuation procedures.

RESEARCH OBJECTIVES

This study will develop a robust platform to create evacuation strategies for Arizona. This resource will evolve through extensive regional data collection, supporting the development of viable simulation tools. The platform will be tested with diverse scenarios, and evacuation strategies will be developed, evaluated, and validated for each scenario. Key resources for the study include a Transportation Research Board web link for transportation security and evacuation research topics, and an FHWA website on emergency operations.

EXPECTED IMPLEMENTATION

This study will develop a platform to analyze and identify the best emergency response and transportation system management strategies for a variety of crisis evacuation scenarios that are directly relevant to Arizona.

The result will be a toolkit for development of operational and effective crisis evacuation plans and management strategies as required by ADOT, and for other partner agencies across the state. It will support internal and joint exercises and planning for critical situations - both those presently anticipated, and those that may evolve in the future.

STATUS OF THE RESEARCH

This project was initiated in April 2007. Initially, the TAC partners furnished several databases and extensive route and resource data to the research team to initially populate the university's evolving MALTA simulation platform. Early tasks included system architecturing, data collection, and evacuation scenario development – including management of regional flooding

and major-event crowd situations. Current efforts continue on integration testing of MALTA, and refinement of the two key scenarios. Following demonstrations of the model in late 2008, a second project (SPR 679) has been approved by ADOT to continue development of this resource.

TECHNICAL ADVISORY COMMITTEE (TAC)

S. Nodes (sponsor)	ADOT Technology Group / Traffic Operations Center
B. Tait (champion)	ADOT-ITD Emergency Management
B. Scott	Arizona Division of Emergency Management
B. Hahn, F. Saleem	Maricopa County DOT
L. Luo, S. Joshua	Maricopa Association of Governments
G. Thum, P. Casertano	Pima Association of Governments
A. Hansen	Federal Highway Administration

SPR-643, Evaluation of Yellow Left-Turn Arrow Phasing and Flash Options

Research Agency:	Pending	FY Authorization:	2007
Principal Investigator(s):	Pending	Contract Date:	Pending
Contract Amount:	Pending	Sched. Completion Date:	Pending
Program Budget:	$24,500	Est. Completion Date:	Pending
Expenditures to date:	$0	On schedule?	N/A
Available Amount:	$24,500	ADVANTAGE No.	R0643 19P
Percent complete Through 6/30/08	0%	Responsible ATRC Staff: (Project Manager)	Frank Darmiento

PROBLEM STATEMENT

A variety of diverse permissive or protected left-turn signal methods are in use across the US, and in various Arizona cities. However, the many options of signal timing, flash or steady-burn mode, and indicator design (ball, arrow, etc) may cause driver confusion, and may increase the risk for left-turn movements. The Arizona Department of Transportation (ADOT) operates more than 550 traffic signals statewide at highway and city-arterial intersections, many of them heavily congested. There is a need to identify potential improvements in clarity and consistency of the left-turn signal message to drivers.

Because of Arizona's steady population and traffic growth, and the expansion in the number of ADOT-controlled intersections, the risk of left-turn crashes remains high. Some local traffic engineering departments have tested or deployed a variety of left-turn signal concepts, as has also been done in other states. ADOT needs to review and evaluate left-turn signal control practices to identify the most practical and safe approaches. The desired outcome will be more consistent operations, and better compatibility at the local-jurisdiction interface.

RESEARCH OBJECTIVES

This study will identify the most relevant control planning tools, signal head patterns, hardware, and technology resources, and it will produce clear recommendations to achieve ADOT's goals, before consideration of implementing any changes on the State system. The project team will review recent literature including relevant work by NCHRP, and contact selected other agencies on the results of options that they have employed. It will review the current control plans and signal head designs of key agencies, in particular those of ADOT and selected Arizona cities.

A key goal is to assess the current theory and applications of various flashing and steady-burn modes and colors for turn arrows. Initial results *may* call for limited testing of options that relate to ADOT's key criteria. The project will recommend how ADOT can standardize its overall approach, technology, and left-turn signal policies with other local traffic agency partners.

EXPECTED IMPLEMENTATION

Both ADOT and local-agency partners will benefit from the results of this study, especially by the establishment of more consistent protected left-turn signal operations, statewide. Left-turn crashes, one of the most frequent and serious types of accident, would be reduced as drivers adapt to the new, more consistent signal modes.

The State Traffic Engineer is expected to implement the successful results of this research, as policy for ADOT. Initially, ADOT regional traffic groups may do pilot deployments and signal control plan revisions, as budgets permit. Wider adaptation by local partners will be recommended.

STATUS OF THE RESEARCH

Pending further definition of scope and project elements, this project has not yet been initiated.

TECHNICAL ADVISORY COMMITTEE (TAC)

G. Gentsch, DE (sponsor)	ADOT Tucson District Engineer
R. Karimvand (champion)	Southern Region Traffic Engineer
R. Moeur	ADOT Traffic Engineering
R. Nassi	City of Tucson
M. Manthey	State Traffic Engineer - ADOT
J. Brown	Federal Highway Administration

SPR-645, Automatic Vehicle Location (AVL) and Maintenance Work Effort Tracking

Research Agency:	Arizona State University	FY Authorization:	2007
Principal Investigator(s):	Dr. Aaron Golub	Contract Date:	2/08/08
Contract Amount:	$20,000 (ASU)	Sched. Completion Date:	9/30/08
Program Budget:	$125,000 (all)	Est. Completion Date:	6/30/09
Expenditures to date:	$46,660	On schedule?	N/A
Available Amount:	$78,341	ADVANTAGE No.	R0645 18P
Percent complete Through 6/30/08	40%	Responsible ATRC Staff: (Project Manager)	Frank Darmiento

PROBLEM STATEMENT

Reliable communication with ADOT maintenance workers is a key management and safety concern, particularly in winter snowfighting efforts. The primary issues are operator safety, and tracking of crew work efforts for accurate reporting. ADOT must know where snowplows are along their routes, if and when those roads were plowed or treated with chemicals, and, at what rate. Environmental issues are also significant. Field managers must be able to document what, when, and how much anti-icing or de-icing chemical is applied along the State's roadways.

Automatic Vehicle Location (AVL) offers better, more timely data for pre-storm planning and for a prompt reaction to changing storm conditions. AVL can provide better information on road conditions for the media and the public. It can improve roadway de-icer usage, and management of stockpiles and plow equipment wear parts. GPS location data will improve driver safety, and by automating daily work records, can also reduce driver workload and stress, and improve their efficiency. More detailed and accurate AVL data will support ADOT against damage claims, and improve recordkeeping on environmental concerns.

The intent of this pilot AVL deployment is to receive, store, interpret, and utilize hard data in place of the hand-written operator reports from memory for a 12-hour plow shift. This hard data will provide a consistent picture of snowplow activity over the winter across the entire district, and a complete history for each route of the locations, events, and performance.

RESEARCH OBJECTIVES

Up to thirty snowplows across the Globe District will be equipped with AVL data systems as a regional pilot test for the 2007-08 winter, in the first effort to install AVL on all of a District's plow trucks. The system will be used on a variety of routes, to determine the extent, quality, and timeliness of the key plowing data needed for rural operations. It will also show if typical rural Arizona cellular service is sufficient to justify this technology, as tested across Globe District's diverse terrain.

EXPECTED IMPLEMENTATION

This research will determine the operational effectiveness of cellular AVL data systems for rural districts. A positive result will justify and support wider deployment of AVL data systems for Arizona's critical snowplowing operations, as well as for other types of heavy equipment.

STATUS OF THE RESEARCH

Due to a late start and problems with commissioning the planned 30 snowplow units with new equipment, there was not enough data to do an analysis. The contractor (ASU) has requested an extension to allow for another winter season's worth of activity (2008-09) before proceeding for the analysis and report. Ultimately, the Final Report will document the degree of success of this snowplowing AVL technology for both the subjective operational performance of the concept, and the quantitative measures defined by the stakeholders. The anticipated implementation will be to champion a wider deployment by ADOT statewide.

TECHNICAL ADVISORY COMMITTEE (TAC)

J. Miller (champion)	ADOT Globe Maintenance Operations Superintendent
J. Barnes (sponsor)	ADOT Globe District Engineer
Globe District Operations Team	All 7 Maintenance Org Supervisors
S. Henson	Globe Maintenance Analyst
C. Willis	Globe Equipment Shop
A. Romero	Show Low Equipment Shop
J. Wakefield, M. O'Malley	Central Fleet Equipment Services
C. Eiserman	ADOT Risk Management
A. Hansen	Federal Highway Administration

SPR-653, *Arizona VII Initiative: Proof of Concept/Operational Testing*

Research Agency:	University of Arizona w/ Arizona State University	FY Authorization:	2007
Principal Investigator(s):	P. Mirchandani (UA); Soyoung Ahn (ASU)	Contract Date:	2/07/08 (both)
Contract Amount:	$165,000 / $35,000	Sched. Completion Date:	6/30/09
Program Budget:	$200,000	Est. Completion Date:	6/30/09
Expenditures to date:	$7,225	On schedule?	Yes
Available Amount:	$192,775	ADVANTAGE No.	R0653 18P
Percent complete Through 6/30/08	05%	Responsible ATRC Staff: (Project Manager)	Frank Darmiento

PROBLEM STATEMENT

Vehicle Infrastructure Integration (VII) is the USDOT initiative to improve safety and mobility through enhanced roadside-to-vehicle and vehicle-to-vehicle communications and real-time information exchanges. Arizona is advanced in applying ITS technologies and in real-time information sharing among public agencies, but our networks are not currently adaptive to actual conditions on the roadways. Non-recurring congestion severely reduces mobility and operational efficiency of the urban area transportation network. Technology provides for adaptive network management, and VII explores how this can be implemented and integrated with legacy systems.

Arizona will research potential VII applications and strategies to support enhanced incident management, and enhanced traffic control through real-time vehicle-to-roadside and vehicle-to-vehicle information sharing. Operations and safety – for incident responders as well as the traveling public - can be enhanced by real-time communications between network management systems and emergency response vehicles.

RESEARCH OBJECTIVES

The Emergency Vehicle focus of the pilot program has led to the "Arizona EVII" working title of this project. Phase 1 will develop and test potential incident management-specific applications: in-vehicle signing/displays, audible in-vehicle warnings, vehicle-to-roadside interfaces, roadside-to-center applications, and vehicle-to-vehicle communications.

Using outcomes of Phase I, the Phase II effort will test and research the successful applications in a pilot deployment. The Arizona EVII Phase II evaluation will assess functionality of the hardware and software, the human factors/responses, and the viability of the technology applications to support enhanced incident management. The project will demonstrate and identify interoperability requirements between new VII technologies and legacy systems. It is also intended to demonstrate enhanced safety benefits by improving real-time communications with emergency response vehicles, and real-time adaptive traffic management strategies.

EXPECTED IMPLEMENTATION

This study will provide an enhanced means of managing traffic based on real-time conditions, particularly for non-recurring incident congestion. In the future, response agencies will benefit from real-time vehicle information as sent to field devices, and to traffic operations centers.

Further outcomes of this Arizona EVII research will include the proof of concept, prototype VII tools, human factors data, and significant inputs to the national VII effort.

STATUS OF THE RESEARCH

Both the University of Arizona and Arizona State University are performing elements of this project scope. The U of A is focused on E-VII technology and software development and the field demonstration scenarios, while ASU will perform the formal evaluation of the program's outcomes. UA will then complete the research report with ASU support.

The project was initiated early in 2008, with efforts to identify the practical goals, site characteristics, and key elements of the field demonstration of specific E-VII resources for emergency responders, including traffic signal preemption and ramp meter overrides. Further, the project is exploring the concept of each response unit serving as an ad-hoc mobile communication hub for other units approaching an incident scene. Planning is under way for a site demonstration in late 2008.

TECHNICAL ADVISORY COMMITTEE (TAC)

S. Nodes (champion)	ADOT-ITD Transportation Technology Group
F. Saleem, (co-champion), and M. Scott	Maricopa County DOT
A. Hansen	Federal Highway Administration

Other response partners TBD:
City of Phoenix Fire
ADOT, Arizona Local Emergency Response Team (ALERT),
Arizona Department of Public Safety (DPS),
MCDOT, Regional Emergency Action Coordinating Team (REACT)

(with) Program Support Consultants (MCDOT) – Kimley-Horn and Associates
(with) EVII Coalition Vendor Partners: Econolite Systems

SPR-678, *Dynamic Routing for Incident Management*

Research Agency:	Pending	FY Authorization:	2009
Principal Investigator(s):	Pending	Contract Date:	Pending
Contract Amount:	Pending	Sched. Completion Date:	Pending
Program Budget:	$50,000	Est. Completion Date:	Pending
Expenditures to date:	$0	On schedule?	N/A
Available Amount:	$50,000	ADVANTAGE No.	R0678 19P
Percent complete Through 6/30/08	0%	Responsible ATRC Staff: (Project Manager)	Frank Darmiento

PROBLEM STATEMENT

Emergency responders must safely and rapidly navigate crowded roadways each day. Congestion, construction, and other factors often block the fastest and safest route to an incident scene. Real-time, robust and flexible routing tools are a critical need for both field response units and their dispatch staff.

RESEARCH OBJECTIVES

E-VII is an Arizona multi-agency program to apply *Vehicle-Infrastructure Integration* technology (*VII*) to critical Emergency services operations. The current ATRC Project SPR 653, *Arizona E-VII Proof of Concept and Operational Testing*, with ADOT and Maricopa County Department of Transportation (MCDOT) funding, uses roadside and on-board communications to share dynamic data among response units and traffic devices.

This new project will support Project SPR 653 by addressing key needs of emergency and dispatch personnel with enhanced decision support and detailed emergency route planning tools. The research will draw heavily from their pool of expertise to develop a conceptual plan for an intelligent vehicle routing system.

This study will augment the current E-VII demonstration project by giving responders better real-time dynamic route-planning resources to reach incident scenes faster and more safely. It will support similar activities at the national level in integrated communications for incident management and emergency response, and potentially expand these capabilities in the future to rural highways.

EXPECTED IMPLEMENTATION

Research results will be implemented in conjunction with application field testing and evaluation, as part of the project SPR 653 for the E-VII Proof of Concept, and in future activities.

The results will also be utilized by MCDOT and ADOT to evaluate potential enhancements or updates to state and regional traffic data systems.

STATUS OF THE RESEARCH

This project has not yet been initiated.

ITS

TECHNICAL ADVISORY COMMITTEE (TAC)

S. Nodes (co-champion)	ADOT-ITD Transportation Technology Group
F. Saleem, (co-champion); M. Scott:	Maricopa County DOT
A. Hansen	Federal Highway Administration

Other response partners TBD:
City of Phoenix Fire
ADOT, Arizona Local Emergency Response Team (ALERT),
Arizona Department of Public Safety (DPS),
MCDOT, Regional Emergency Action Coordinating Team (REACT)

(with) Program Support Consultants (MCDOT) – Kimley-Horn and Associates
(with) EVII Coalition Vendor Partners: Econolite Systems

SPR-679*, Platform for Evaluating Emergency Evacuation Strategies – Phase II*

Research Agency:	Pending	FY Authorization:	2009
Principal Investigator(s):	Pending	Contract Date:	Pending
Contract Amount:	Pending	Sched. Completion Date:	Pending
Program Budget:	$200,000	Est. Completion Date:	Pending
Expenditures to date:	$0	On schedule?	N/A
Available Amount:	$200,000	ADVANTAGE No.	R0679 19P
Percent complete Through 6/30/08	0%	Responsible ATRC Staff: (Project Manager)	Frank Darmiento

PROBLEM STATEMENT

All emergency operational planning suffers from the inability to analyze, rehearse, and exercise responses to large scale incidents. The ideal operation plan must perform from the global scale, down to the entity/individual level; however, there is no current simulation capability to reliably test those plans. Realistic field exercises are impossible due to the cost and complexity of closing roads, civilian involvement, and area safety control, among other issues. Exercises attempted in the past employed unrealistic assumptions and were confined to artificial exercise areas, resulting in limited benefits to participants and flawed "lessons learned" that may increase the risk to public safety. It is imperative that the planning process for complex operations identify command and control options, intervention techniques, and responder actions to be inserted in real time into the simulation, and enable success or failure to be analyzed accurately and in depth. Working at this level of fidelity requires real-time inputs and outputs and geo-specific inter-visibility of movements. All of this must be effective down to the entity level - a capability that does not yet exist.

RESEARCH OBJECTIVES

This project, in the absence of suitable existing tools, will build on the Arizona Transportation Research Center's current project SPR-634, which has created a Phoenix-area database to fully employ the functionality of the new Multi-resolution Assignment and Loading of Transportation Activities (MALTA) modeling platform.

The objective is to develop a real-time, geo-specific, threat-specific simulation tool capable of replicating individual vehicle and person actions, responder actions, and unscripted operations initiatives.

EXPECTED IMPLEMENTATION

As ADOT's ability improves to examine plans that deal with large, complex operations, it will increase its capacity to better control high traffic flow durations, test and rehearse complex emergency response plans, and increase public safety. In addition to testing plans/strategies, the project will provide a tool for alleviating traffic congestion whether in new construction planning or planning for a large event.

If the developed platform works as well as anticipated, state emergency and traffic planners will make use of the models immediately as they are constructed.

ITS

STATUS OF THE RESEARCH

This project has not yet been initiated.

TECHNICAL ADVISORY COMMITTEE (TAC)

S. Nodes (sponsor)	ADOT Technology Group / Traffic Operations Center
B. Tait (champion)	ADOT-ITD Emergency Management
B. Scott	Arizona Division of Emergency Management
B. Hahn, F. Saleem	Maricopa County DOT
L. Luo, S. Joshua	Maricopa Association of Governments
G. Thum, P. Casertano	Pima Association of Governments
A. Hansen	Federal Highway Administration

Others TBD:
ADOT Districts; City of Tucson

SPR-681, *Work Zone Instant Driver Warnings: Speed or Penalty Messages*

Research Agency:	Pending	FY Authorization:	2009
Principal Investigator(s):	Pending	Contract Date:	Pending
Contract Amount:	Pending	Sched. Completion Date:	Pending
Program Budget:	$62,500	Est. Completion Date:	Pending
Expenditures to date:	$0	On schedule?	N/A
Available Amount:	$62,500	ADVANTAGE No.	R0681 19P
Percent complete Through 6/30/08	0%	Responsible ATRC Staff: (Project Manager)	Frank Darmiento

PROBLEM STATEMENT

Excess speeds in construction work zones (as well as other zones, e.g., school, maintenance, etc.) cause safety problems to workers, pedestrians and vehicle drivers. Deployment of portable photo radar equipment is one current method of providing feedback to drivers as to their actual speed, but is a limited resource. Dynamic Message Signs (DMS) are often used but have no feedback capability.

RESEARCH OBJECTIVES

This research proposes to explore providing the driver with different feedback information--namely the amount of the dollar fine that would be imposed if the driver were cited for a speeding violation at the speed and location that the radar sensor measures. Comparisons would be made among (a) using speed feedback only, (b) using dollar traffic fine only, and (c) using both speed and traffic fine feedback

EXPECTED IMPLEMENTATION

This project is expected to benefit both the public and ADOT regarding safety in zones for both workers and drivers; it is expected to provide ADOT with a potential method to improve speed reduction compliance in maintenance and construction zones. Benefits will potentially be realized with reduced speeds in work zones, which could reduce collisions. If the research is successful, then speed reduction in work (school) zones could save injury, property damage, and lives of workers and drivers. After proof of concept, a prototype(s) could be installed for more extensive field-testing, prior to statewide implementation.

STATUS OF THE RESEARCH

This project has not yet been initiated.

TECHNICAL ADVISORY COMMITTEE (TAC)

S. Nodes (sponsor)	ADOT Technology Group / Traffic Operations Center
J. Harper (champion)	ADOT-ITD Flagstaff District
K. King	Federal Highway Administration

Others TBD

SPR-682, ***Analysis of Freeway Bottlenecks: Capacity Reduction and Temporal Variations***

Research Agency:	Pending	FY Authorization:	2009
Principal Investigator(s):	Pending	Contract Date:	Pending
Contract Amount:	Pending	Sched. Completion Date:	Pending
Program Budget:	$80,000	Est. Completion Date:	Pending
Expenditures to date:	$0	On schedule?	N/A
Available Amount:	$80,000	ADVANTAGE No.	R0682 19P
Percent complete Through 6/30/08	0%	Responsible ATRC Staff: (Project Manager)	Frank Darmiento

PROBLEM STATEMENT

Traffic congestion is a major externality in modern transportation systems and has a negative economic, environmental and social impact. The 2007 Urban Mobility Report (Schrank and Lomax, 2007) states that the cost of congestion, in terms of delay and wasted fuel, is estimated to be about $78 billion in urban areas in the United States. This cost has steadily increased since 1982, and the trend will likely continue.

In the Phoenix metropolitan region, there are several recurrent bottlenecks, some of which result in long queues and large delays during rush hours. These bottlenecks have already been identified as part of the 2002 Maricopa Association of Governments (MAG) Freeway Bottleneck Study, which has provided general assessment and recommendations of countermeasures. However, developing effective countermeasures to improve freeway operations would benefit from more detailed analysis of various bottleneck features. Thus, this research will focus on several key bottlenecks and perform in-depth analysis to study the mechanism of bottleneck activation and temporal variation.

RESEARCH OBJECTIVES

The primary objective of this research is to provide a better understanding of detailed features of major recurring bottlenecks in the Phoenix metropolitan region and their temporal variations. The following list details the objectives that this study will attempt to achieve:

(1) Identify recurring bottlenecks that typically result in severe congestion
(2) Study the activation mechanism of the identified bottlenecks
(3) Evaluate the bottleneck capacity upon activation
(4) Evaluate the temporal variations in capacity
(5) Identify the factors that are significant to the variations.

This research is expected to enhance our understanding on behavior of bottlenecks in the Phoenix metropolitan area, to reduce variations in travel time perceived by users and to provide faster and more reliable services.

EXPECTED IMPLEMENTATION

It is anticipated that findings from this research will offer important knowledge to practitioners to develop guidelines for strategic planning for effective congestion management. In specific, this study would allow one to evaluate the congestion management systems that are currently deployed and identify the needs for new system implementations or any possible improvements

of existing systems. Findings from this study will thus help develop a range of short-term solutions as well as longer-term initiatives that are practical and cost-effective. The solutions may include expansion of roadway, investments for intelligent transportation systems infrastructure for technology-based solutions, or ultimately, demand management.

STATUS OF THE RESEARCH

This project has not yet been initiated.

TECHNICAL ADVISORY COMMITTEE (TAC)

S. Nodes (champion/sponsor)	ADOT-ITD Transportation Technology Group
S. Joshua	Maricopa Association of Governments,
K. King	Federal Highway Administration
Others TBD:	ADOT District Maintenance

Maintenance – PROJECTS

SPR-500, *Aggregate Sources for Construction and Maintenance in Northern Arizona*

Research Agency:	Prophecy Consulting	FY Authorization:	2005
Principal Investigator(s):	Vi Brown	Contract Date:	7/18/07
Contract Amount:	$235,254	Original Completion Date:	January 2009
Program Budget:	$250,000	Estimated Completion Date:	January 2009
Expenditures to date:	$101,843	Is project on schedule?	Yes
Available Amount	$133,411	ADVANTAGE No.	R050012P
Percent complete through 06/30/08	44%	Responsible ATRC Staff: (Project Manager)	Jason Harris

PROBLEM STATEMENT

For the greater part of the interstate construction program, the Arizona Department of Transportation (ADOT) maintained the responsibility to locate acceptable aggregate sources for construction purposes. ADOT would locate sources of material, obtain all clearances and permits and perform the geotechnical analysis of the pit composition. At one time, ADOT maintained a database of over 8,000 material pits located around the state. This process made ADOT liable for material acceptability and often times resulted in claims from the contracting industry based upon misrepresentation of the character or quantity of material involved.

In more recent times ADOT turned over the material source issue to the contracting sector. The contractor currently is responsible for locating and obtaining pits for each individual construction project. This makes the contractor entirely responsible for his quality and quantity of material obtained.

Recently, material sources are becoming increasingly more difficult to find and use, even for the private sector. Many of the material sources in northern Arizona are located within reservations and the Indian nations have been less willing to allow access and use.

The lack of material availability is even affecting aggregate sources for maintenance use. There is a need to provide reliable aggregate sources for construction and maintenance activities.

RESEARCH OBJECTIVES

The objective of this research is to identify the aggregate sources available for construction and maintenance in northern Arizona and to determine the means by which these sources will be used.

The following minimum tasks will be performed:

1. Conduct a literature search relevant to available aggregate sources in Arizona.
2. Canvass the construction industry and other governmental agencies to establish additional pit sources and potential options for providing aggregate sources such as regionally located designated sources and or designated locations where materials are transported to or where

large aggregate crushing contracts are established to provide material sources for many projects.

3. Canvass ADOT construction and maintenance personnel for problem identification and potential solutions.
4. Determine the locations/potential locations of all available material sources in northern Arizona for use by the highway community.
5. Prepare a working paper summarizing the recommendations for providing aggregate sources for construction and maintenance purposes in northern Arizona for the next ten years. The working paper will provide all the justification and supplemental information necessary to support the recommendations.
6. Upon approval of the recommendations submitted in Task 5, develop an implementation plan that will provide the material sources necessary for construction and maintenance operations in northern Arizona for the next ten years. The plan will specify each location, the plan for developing the site(s) and any process changes necessary to use the sources.
7. Prepare a final report documenting the efforts of the study and the conclusions and recommendations.
8. Prepare a Research Note in accordance with Arizona Transportation Research Center (ATRC) procedures.
9. Conduct an executive presentation to the Research Council.

EXPECTED IMPLEMENTATION

The results from this research project will establish the aggregate sources for construction and maintenance activities in Northern Arizona.

STATUS OF THE RESEARCH

This project is underway. The first four tasks have been completed.

TECHNICAL ADVISORY COMMITTEE (TAC)

John Lawson	Materials Group, Champion/Sponsor
Doug Forstie	State Engineers Office
Jim Delton	Materials Group
Randy Vuletich	Materials Group
Allan Samuels	Construction Section
Lynn Johnson	Holbrook District
Randy Pair	Holbrook District
Chad Auker	Flagstaff District
Mike Rice	State Land Department
Tom Deitering	FHWA
Stan Robbins	Apache County

SPR-536, *Improved Snow Plow Headlight Visibility and Reduced Driver Fatigue*

Research Agency:	Best Highway Safety Practices Institute	FY Authorization:	2002
Principal Investigator(s):	Chad Dornsife	Contract Date:	1/11/07
Contract Amount:	$47,000	Original Completion Date:	January 2008
Program Budget:	$50,000	Estimated Completion Date:	December 2008
Expenditures to date:	$2,400	Is project on schedule?	No
Available Amount	$44,600	ADVANTAGE No.	R053614P
Percent complete Through 6/30/08	5%	Responsible ATRC Staff: (Project Manager)	Jason Harris

PROBLEM STATEMENT

Plowing snow is very difficult, but very necessary. Poor weather reduces visibility. This problem is further exacerbated by the need to mount headlights higher on the equipment so they shine over the plows. This often results in the plow lights being almost at the operators' eye level, which is the worst condition for reflecting light back into the snowplow driver's eyes, obscuring their vision even more. This headlight position also reduces visibility for on-coming traffic since the headlights are higher than normal. The additional colored beacon lights that are used on plows as warning devices also reflect off of the snow into the operator's eyes. Although these lights are mounted behind the driver, they still reflect off the snow and obscure vision. Other problems that exist during plowing operations are the visibility through the windshield due to fogging over and the effectiveness of the wipers themselves.

An informal survey was conducted in 2005 at a meeting mostly attended by ADOT maintenance staff. Of the 50 to 100 respondents, not one operator felt that snowplow visibility was adequate. This is an alarming statistic since clearing of the roadway is the most significant safety improvement ADOT can make for the traveling public during the winter season.

In addition to the reduced vision caused by these problems, increased driver fatigue is experienced. Since plowing snow is such a difficult event, anything that contributes to additional fatigue should be minimized or eliminated.

This problem was the focus of a recently completed National Cooperative Highway Research Program (NCHRP) study that made recommendations for improvements. ADOT's previous study on Winter Storm Operations also made recommendations to improve plow operations. However, no recommendations to improve lighting configurations have been provided to eliminate the problems described.

RESEARCH OBJECTIVES

The objective of this research is to increase operator visibility and to reduce glare to on coming traffic during plowing operations.

The following tasks, at minimum, will be accomplished:

1. Review recommendations of previous research, other state's practices, and available equipment.

2. Recommend the necessary equipment and procedures to improve driver visibility and to reduce glare to on-coming traffic. The recommendations should include costs.
3. Purchase the equipment and attachments necessary to retrofit one of ADOT's existing plows with the recommended equipment and demonstrate the visibility improvement through video documentation during inclement weather.
4. Document improvements to worker safety as a result of the installed devices/modified practices. The evaluations should be a before and after study
5. Prepare a final report documenting the research methodologies, findings, and recommendations and conclusions.
6. Prepare an Arizona Transportation Research Center (ATRC) Research Note for distribution.
7. Prepare an executive presentation on the findings to the Research Council.

EXPECTED IMPLEMENTATION

The results of this research would be used to modify ADOT's snowplow fleet.

STATUS OF THE RESEARCH

Due to mild winters in Arizona, data analysis is limited to the field data that was collected during the 06/07 and 07/08 winter seasons.

TECHNICAL ADVISORY COMMITTEE (TAC)

Danny Russell	Flagstaff Maintenance, Champion/Sponsor
Kent Link	Flagstaff Maintenance
Carl Eyrich	Flagstaff Equipment Services
Eddie Faultner	Williams Maintenance
Todd Russell	Williams Maintenance
Dean Murgiuc	Equipment Services
Joel Miller	Globe District
Robert Wilbanks	Holbrook District
David Sattler	Kingman District

SPR-617, Evaluate Effects of Snowplow and Deicing Chemicals on Rubberized Asphalt Pavements

Research Agency:	Nichols Consulting Engineers, Chtd.	FY Authorization:	2006
Principal Investigator(s):	Rita Leahy	Contract Date:	3/16/07
Contract Amount:	$116,740	Sched. Completion Date:	December 2008
Program Budget:	$116,740	Est. Completion Date:	December 2008
Expenditures to date:	$36,088	On schedule?	Yes
Available Amount:	$80,652	ADVANTAGE No.	R061718P
Percent complete Through 6/30/08	30%	Responsible ATRC Staff: (Project Manager)	Jason Harris

PROBLEM STATEMENT

The application of de-icing chemicals to roads is a required winter maintenance method in order to maintain traffic safety. However, de-icing chemicals may have potential adverse impact on pavement surface. Most pavement surface damage results from a natural process called the freeze-thaw cycle. The freeze-thaw cycle involves moisture seeping into the cracks and surface pores and freezing. As the moisture changes to ice, it expands which puts stress on surfaces. De-icing chemicals increase the number of freeze-thaw cycles and can also double the rate of expansion during freezing. Weak pavements may crack or pit under this added stress. There is also a question as to whether the chemicals (chlorides and ant-corrosive agents) have an effect on the asphalt and rubber in the rubberized friction course. The chemicals may speed up the natural oxidation process and shorten the pavement life. To avoid pavement damage, using a pure traction aid such as garnet sand, rather than ice melting chemicals may be an option. However, if the maintenance of a clear highway is critical, the risk of surface damage against the potential liability must be considered. In Arizona, almost all the interstate highway pavement and most of the other pavement is surfaced with a rubberized friction course. The impact of the application of de-icing chemicals on rubberized pavements is not fully understood.

RESEARCH OBJECTIVES

The objectives include: (1) using field and laboratory experiments, evaluate the effect of the application of various ice and snow melting chemicals on rubberized pavements; and (2) select the most cost-effective ice and snow melting chemical blends, and application rate and procedure, and other accompanying pavement maintenance strategies for rubberized pavements to meet the goals of both traffic safety and reducing pavement damages related to the application of de-icing

EXPECTED IMPLEMENTATION

District maintenance groups will implement the suggestions regarding applying de-icing chemicals. Materials group can implement the new findings regarding asphalt mix.

STATUS OF THE RESEARCH

The project is underway.

Maintenance

TECHNICAL ADVISORY COMMITTEE (TAC)

Julie Kliewer	Materials Group, Champion
Roy Alvis	Prescott District
Chad Auker	Flagstaff District
Joel Miller	Globe District
Tom Deitering	FHWA

SPR-628, *Evaluation of Maintenance Strategies for ADOT*

Research Agency:	Applied Pavement Technology, Inc.	FY Authorization:	2007
Principal Investigator(s):	David Peshkin	Contract Date:	8/01/07
Contract Amount:	$100,000	Sched. Completion Date:	January 2009
Program Budget:	$100,000	Est. Completion Date:	January 2009
Expenditures to date:	$48,125	On schedule?	Yes
Available Amount:	$51,875	ADVANTAGE No.	R062819P
Percent complete Through 6/30/08	48%	Responsible ATRC Staff: (Project Manager)	Jason Harris

PROBLEM STATEMENT

ATRC research project SPR-371, *Maintenance Cost Effectiveness Study*, studied several hundred test sections throughout Arizona in three project phases. The study phases are wearing courses (Phase I), surface treatments (Phase II), and sealer-rejuvenators (Phase III). While the project came to an end by 2005, the maintenance strategies applied still have their anticipated remaining life ranging from 4 to 9 years. As a result, some of the goals of the SPR-371 project could not be met. Through further monitoring of those test sections, overall performance of the maintenance strategies related to environment, location, cost, availability etc. can be identified.

RESEARCH OBJECTIVES

1. Review ADOT's current maintenance strategies.
2. Document the materials (binder, admixture, aggregates etc.), gradation and volumetrics etc., used in each of the test treatment of the maintenance research project SPR-371.
3. Fully monitor the test sections constructed under maintenance research project SPR-371.
4. Evaluate performance of the maintenance strategies done in those sections.
5. Identify the effectiveness of maintenance treatments based on a matrix of cost, type of distress, location, constructability, service life etc.
6. Develop a specific provisional guideline of effective maintenance strategies for ADOT to follow.

EXPECTED IMPLEMENTATION

ADOT maintenance groups will use the resulting information to improve their practices.

STATUS OF THE RESEARCH

The project is underway.

Maintenance

TECHNICAL ADVISORY COMMITTEE (TAC)

Lonnie Hendrix	Central Maintenance, Champion
Jim Delton	Materials Group, Sponsor
Bill Hurguy	Materials Group
Javed Bari	Materials Group
Paul Burch	Materials Group
Doug Forstie	State Engineers Office
Steve Puzas	Safford District
Joel Miller	Globe District
Sharon Gordon	FHWA

SPR-632, *Development of Materials for Repairing AR-ACFC Surfaces*

Research Agency:	Pending	FY Authorization:	2007
Principal Investigator(s):	Pending	Contract Date:	Pending
Contract Amount:	Pending	Sched. Completion Date:	N/A
Program Budget:	$100,000	Est. Completion Date:	N/A
Expenditures to date:	0	On schedule?	N/A
Available Amount:	$100,000	ADVANTAGE No.	R063219P
Percent complete Through 6/30/08	0%	Responsible ATRC Staff: (Project Manager)	Christ Dimitroplos

PROBLEM STATEMENT

The predominant surface treatment on ADOT interstate and high volume roadways is an Asphalt-Rubber/Asphalt-Concrete Friction Courses (AR-ACFCs). These open graded materials are somewhat porous and are designed to drain the roadway surface quicker than standard pavements. They provide better wet-weather friction, better stripe delineation and produce less headlight glare. They are also generally quieter than conventional dense graded mixtures. Conventional hot mix or cold mix repair materials are not suitable for these somewhat porous surfaces. Non-porous repair materials behave as a dam within the AR-ACFC, trapping water and accelerating its deterioration. Currently there is no readily available material to repair AR-ACFC surfaces effectively. There is a need to develop and evaluate materials suitable for repairing AR-ACFC surfaces.

RESEARCH OBJECTIVES

The objectives of this task are to develop/find materials for repairing AR-ACFCs and ACFCs and evaluate their acceptability for maintenance repairs.
The following tasks, at minimum, will be accomplished:

1. Review available materials for repairing open graded friction courses.
2. Produce repair materials and construct field test sections for evaluation.
3. Monitor the performance of the materials for three years.
1. Prepare a final report documenting the research methodologies, findings, and recommendations and conclusions.
2. Prepare an Arizona Transportation Research Center (ATRC) Research Note for distribution.
3. Prepare an executive presentation on the findings to the Research Council.

EXPECTED IMPLEMENTATION

If the research is successful, implementation would be immediate. The products developed in this research would be used by ADOT maintenance to repair open graded friction courses.

STATUS OF THE RESEARCH

The project is not yet underway.

Maintenance

TECHNICAL ADVISORY COMMITTEE (TAC)

Greg Gentsch	Tucson District, Champion/Sponsor
Doug Forstie	State Engineers Office
Lonnie Hendrix	Central Maintenance
Jim Delton	Materials Group
Danny Russel	Flagstaff District
Roy Alvis	Prescott District
Julie Kliewer	Materials Group
Tom Deitering	FHWA

SPR-649, Safety Issues Due to Unforeseen Stoppage of High Speed Mainline Traffic

Research Agency:	Pending	FY Authorization:	2008
Principal Investigator(s):	Pending	Contract Date:	NA
Contract Amount:	Pending	Sched. Completion Date:	NA
Program Budget:	$60,000	Est. Completion Date:	NA
Expenditures to date:	0	On schedule?	NA
Available Amount:	$60,000	ADVANTAGE No.	R064920P
Percent complete Through 6/30/08	0%	Responsible ATRC Staff: (Project Manager)	Jason Harris

PROBLEM STATEMENT

As the traffic characteristics change on our interstates, freeways and principal arterials, there are potential safety issues associated with increased traffic volume, congestion, sudden bottleneck, speed differential, non-use or misuse of HOV lane, under-use of alternative routes, etc. The situation becomes worse with highway work zones and unpredictable incidents. The problem is to perform a comprehensive literature review on the best practices to handle these types of situation, analyze a few candidate locations on Arizona highways and develop countermeasures. A possible engineering solution to this problem could be an application of the Intelligent Transportation System (ITS), e.g. using sensors detecting slow-moving or stopped vehicles, Variable Message Signs (VMS) with real-time coordination to provide dynamic and effective motorists' information. The proposed project will look into all effective and feasible solutions addressing the issues.

RESEARCH OBJECTIVES

This proposal encompasses a study to address the safety issues due to unforeseen stoppage of mainline traffic on our highways. The following deliverables are proposed:

- Summary of best practices
- Analysis of candidate locations
- Recommendation plans
- Rough cost estimates

The outcome of this research project will provide a direction to resolve the issues discussed above. Implementation of the recommendation plans will obviously be contingent upon the budget and ADOT approval.

EXPECTED IMPLEMENTATION

The results can be implemented in coordination with the existing ITS applications on ADOT highway systems. Traffic Operations, ITS Group or HES Section will be responsible for this implementation. If this research is quite comprehensive, a minimal follow-up research may be required. Cost of implementation cannot be estimated until the project is completed.

STATUS OF THE RESEARCH

The project is not yet underway.

Maintenance

TECHNICAL ADVISORY COMMITTEE (TAC)

Mike Manthey	Traffic Engineering, Champion/Sponsor
Reed Henry	HES
TBD	Traffic Engineering
TBD	Traffic Operations
Cindy Eiserman	Risk Management
Jeff King	DPS
Karen King	FHWA

Materials and Construction – PROJECTS

SPR-396, *LTPP and Other Test Section Management and Evaluation*

Research Agency:	Arizona Transportation Research Center	FY Authorization:	1995
Principal Investigator(s):	Nichols Consulting	Contract Date:	10/28/2005
Contract Amount:	N/A	Scheduled Completion Date:	6/30/2007
Program Budget:	$356,000	Estimated Completion Date:	06/30/2009
Expenditures to date:	$158,000	Is project on schedule?	Yes
Available Amount	$198,000	ADVANTAGE No.	R039618P
Percent complete through 06/30/06	75 %	Responsible ATRC Staff: (Project Manager)	Christ Dimitroplos

PROBLEM STATEMENT

This project has been re-scoped and represents a consolidation of what was previously SPR 388, 390, 391, 393, and 395. Instead of having multiple projects, the efforts have been consolidated into SPR 396, which previously was just for GPS testing and evaluation. In FY 2006 all data collection was completed. A draft interim report analyzing the data for SPS 1, SPS-4, SPS-6, and SPS-9 is currently being reviewed.

RESEARCH OBJECTIVES

The objective of this project is to ensure the maintenance and evaluation of the ongoing LTPP test sections.

At a minimum, the following tasks will be accomplished:

1. Maintain the signing and pavement markings on all test sections.
2. Conduct filming of distress on test sections, digitize imagery, and conduct analysis of images.
3. Conduct forensic investigations on analysis of test section performance.

EXPECTED IMPLEMENTATION

This project provides for data collection, evaluation, and analysis to support the LTPP program and ADOT's pavement preservation program.

STATUS OF THE RESEARCH

This was an on-going activity monitoring the recently ended service life (15-20 years) of each of the test sections. In June 2007, the Research Council approved an additional $150,000 to conduct full data testing and analysis of the now out-of-study sections. Evaluation reports on the SPS profiles, and the SPS-5 and SPS-6 experiments are underway by Nichols Consulting, Inc. Interim reports have been submitted for all SPS profiles.

Materials and Construction

TECHNICAL ADVISORY COMMITTEE (TAC)

Doug Forstie	State Engineer's Office
Jim Delton	Materials Group
Julie Kliewer	Materials Group
Paul Burch	Materials Group
Murari M. Pradhan	Regional Materials Engineer
David Burbank	Regional Materials Engineer
Chad Auker	Regional Materials Engineer
Tom Deitering	FHWA

SPR-575, *Concrete Aggregate Durability Study*

Research Agency:	Applied Pavement Technology	FY Authorization:	2004
Principal Investigator(s):	David Peshkin	Contract Date:	05/03/2004
Contract Amount:	Pending	Sched. Completion Date:	10/30/2005
Program Budget:	$37,000	Est. Completion Date:	3/30/2008
Expenditures to date:	$17,006	Is project on schedule?	No
Available Amount	$19,994	ADVANTAGE No.	R057516P
Percent complete through 06/30/05	70%	Responsible ATRC Staff: (Project Manager)	Christ Dimitroplos

PROBLEM STATEMENT

The durability of concrete aggregate has long been a problem in the transportation community. In particular, Alkali-Silica Reactivity (ASR) and Sulfate attack have been the two predominant problems associated with long-term concrete durability. Although considered an issue in surrounding states, this has not been considered a serious problem for structures or bridges in Arizona. Unfortunately, these problems typically take many years to manifest themselves and once detected, corrective action is often times difficult to undertake. So prevention is the best solution.

ASR and sulfate attack, although different distress mechanisms, occur as a result of an interaction between the environment and the concrete. Both distresses cause expansion within the hardened concrete resulting in cracking of the concrete.

A recent study on a major airfield in Arizona determined that significant alkali-silica reaction had occurred in the 14-year old concrete pavement. This suggests that this may be more of a concern than previously believed. This, coupled with the fact that it is an issue in surrounding states with similar geological sources, suggests that this needs further research.

RESEARCH OBJECTIVES

The objective of this research would be to review the available knowledge regarding aggregate problems in Arizona and the surrounding states. The minimum following tasks would be performed:

Conduct Literature Search

Canvass the industry and agencies for published and unpublished experience

Review specifications used in Arizona and surrounding states for mitigating the impact of ASR and Sulfate.

Prepare a report documenting the findings of the previous tasks and identifying any needed specification changes to ADOT's current concrete specifications.

EXPECTED IMPLEMENTATION

The product of this effort would be a report detailing the available information on aggregate performance in Arizona and surrounding states.

STATUS OF THE RESEARCH

The project was just awarded.

TECHNICAL ADVISORY COMMITTEE (TAC)

Christ Dimitroplos, ADOT-ATRC
Jeff Hearne, Salt River Materials Group
Robert Barkley, Hanson Materials
David Burbank, ADOT-Materials
Scott Weinland, ADOT-Materials
Murari Pradhan, ADOT- Materials
Aryan Lirange, FHWA
Tom Deitering, FHWA

SPR-577, *Pavement Noise Study*

Research Agency:	Illingworth and Rodkin	FY Authorization:	2004
Principal Investigator(s):	Paul Donovan	Contract Date:	Pending
Contract Amount:	Pending	Sched. Completion Date:	9/30/2010
Program Budget:	$99,000 (FY2008) ($657,000 total *)	Est. Completion Date:	9/30/2010
Expenditures to date:	$0	Is project on schedule?	Yes
Available Amount	$97,000	Advantage No.	R057717P
Percent complete through 06/30/07	50%	Responsible ATRC Staff: (Project Manager)	Christ Dimitroplos

* See Table in Status of Research Heading

PROBLEM STATEMENT

Historically, noise mitigation measures used in the U.S. transportation industry have included use of barriers, walls, and separation (e.g., distance). These methods have been the only acceptable solutions for federally funded projects. Quiet pavements can also be used to mitigate noise but are not currently permitted because the Federal Highway Administration (FHWA) does not view them as a permanent solution.

In Arizona, like other states, berms and walls are the primary noise mitigation measures in the urban corridors. In April 2003, ADOT received approval from FHWA to allow the use of pavement surface type as a noise mitigation strategy. This approval allowed the use of Asphalt Rubber Friction Course (ARFC) overlays as a noise mitigation strategy when used on existing and newly constructed concrete pavements. Where this surfacing is used, ADOT receives a four-decibel reduction for the design of walls and berms. This credit equates to a six to eight foot reduction in wall or barrier height. Perhaps a more meaningful analogy is that if just a three-decibel reduction were achieved through the use of a quiet pavement, it would have a noise impact of about half of the actual traffic volume.

The FHWA approval was granted with the condition that Arizona be a pilot program, with specific research objectives and requirements. The required research is intended to validate the efficacy of using ARFC as a noise mitigation strategy. Since the FHWA was concerned that a pavement solution is not a permanent solution, they requested a pilot program to study the long-term performance of the ARFC overlay. ADOT committed to a long-range study for up to 10 years, the estimated minimum life cycle of the ARFC pavement.

The ADOT Intermodal Transportation Division (ITD) is currently conducting studies of Type 2 (wayside noise measurement) sites. The ITD studies will complement this research, which focuses on Type 1 (source noise) and Type 3 (research grade) sites.

Materials and Construction

RESEARCH OBJECTIVES

The objective of the research is to measure and compare noise generated from different pavement types over time. The effects of pavement design and pavement age will be monitored as they affect noise generation from vehicle traffic.

EXPECTED IMPLEMENTATION

The results of the research will be used in the design of future road construction projects.

STATUS OF THE RESEARCH

A Joint Project Agreement (JPA) with the Arizona State University (ASU) Materials Group and a JPA with the ASU Environmental Group are complete. A JPA with the Federal Highway Administration Volpe Center is also complete. The table below shows funding in the corresponding fiscal years:

SPR Fund Source	FY 2004	FY 2005	FY 2008	FY 2010	Totals
Part I (Planning)	$364,000	-	-	-	$364,000
Part II (Research)	-	$99,000	$97,000	$97,000	$293,000
			Program Total		**$ 657,000**

TECHNICAL ADVISORY COMMITTEE (TAC)

Floyd Roehrich	State Engineer's Office
Frank Darmiento	ATRC
Barney Remington	EEG
Fred Garcia	EEG
Thor Anderson	EEG
Ali Zareh	Pavement Design
Mary Frye	FHWA
Bill Vachon	FHWA

SPR-590, *Performance Related Pay Factors for Asphalt Concrete*

Research Agency:	Arizona State University	FY Authorization:	2005
Principal Investigator(s):	Dr. Matt Witczak	Contract Date:	03/08/ 2005
Contract Amount:	$50,000	Sched. Completion Date:	03/08/ 2006
Program Budget:	$50,000	Est. Completion Date:	10/27/ 2006
Expenditures to date:	$50,000	Is project on schedule?	Yes
Available Amount	$0	ADVANTAGE No.	R059017P
Percent complete through 06/30/05	95%	Responsible ATRC Staff: (Project Manager)	Christ Dimitroplos

PROBLEM STATEMENT

Currently, ADOT accepts asphalt concrete production based on ten different quality factors. These include: sand equivalent, fractured coarse aggregate particles, uncompacted void content (special mix), material spread, gradation, asphalt cement content, effective voids, stability, compaction, and smoothness.

Of these ten, four are used to determine the mixture-properties and compaction pay factor. They are gradation, asphalt cement content, effective voids, and compaction. The mixture property and compaction pay factor is used to pay the contractor for each ton of asphalt produced on the project. The purpose of the mixture pay factor is to determine payment, based upon on the percent of product within a specified tolerance. This allows payment to be based upon mixture quality. That is, the higher the quality the higher resulting payment.

The mixture property and compaction pay factors were largely developed on experience and judgment and on production equipment capability. The linkage between these pay factors and pavement performance and pavement design is currently not known.

It would be very beneficial to have pay factors that are based upon actual pavement performance and design procedures. The recently completed NCHRP 2002 Pavement Analysis tool provides the capability to evaluate the effect of these mixture characteristics on pavement design and performance. Therefore, rational pay factors could be determined based upon actual design conditions and attendant pavement performance.

RESEARCH OBJECTIVES

The objective of this research is to develop new pay factors for inclusion into ADOT's specifications based upon analysis conducted using the NCHRP 2002 Pavement Analysis Tool. Sensitivity analysis will be conducted for each of the relevant mixture and compaction properties to determine their effect on pavement performance.

EXPECTED IMPLEMENTATION

The results of this research should be used to replace the pay factors shown in section 416 of the standard specifications.

Materials and Construction

STATUS OF THE RESEARCH

The project research has been completed. A draft final report is currently being reviewed.

TECHNICAL ADVISORY COMMITTEE (TAC)

Jim Delton	Materials Group
Julie Nodes	Materials Group
Paul Burch	Materials Group
Javed Bari	Materials Group
Christ Dimitroplos	ATRC
John Shi	MCDOT-Materials
Bob McGennis	Holly Asphalt

SPR-605, *Investigations of Environmental Effects on Freeway Acoustics*

Research Agency:	Arizona State University	FY Authorization:	2006
Principal Investigator(s):	Dr. Joe Fernando	Contract Date:	05/04/2006
Contract Amount:	$90,000	Sched. Completion Date:	05/04/2007
Program Budget:	$90,000	Est. Completion Date:	05/04/2008
Expenditures to date:	$90,000	Is project on schedule?	Yes
Available Amount	0	ADVANTAGE No.	R060518P
Percent complete through 06/30/05	95%	Responsible ATRC Staff: (Project Manager)	Christ Dimitroplos

PROBLEM STATEMENT

In April of 2003, ADOT received approval from the FHWA to allow the use of pavement surface type as a noise mitigation strategy. This was granted with the condition that Arizona would conduct a pilot program related to this strategy. A research program was developed to validate the efficacy of using Asphalt Rubber Friction Courses (ARFC) as a noise mitigation strategy. ADOT has begun to monitor four sites across the Phoenix Metropolitan area over a ten-year period to evaluate the effectiveness of ARFC. Recent experiences, however, suggest that traditional noise abatement approaches (e.g. the use of walls) can be defeated by environmental conditions. In the last year, researchers at Arizona State University helped ADOT to monitor environmental conditions associated with acoustic monitoring. In the first (completed) phase, the effects of winds on noise propagation were studied. However, the effects of inversions have not been studied, although they are known to be important; and this will be focus of the proposed work.

RESEARCH OBJECTIVES

In order to understand the influence of stability (inversion) conditions on sound propagation, we will conduct environmental monitoring, concurrent with ADOT acoustic monitoring, under different stability conditions -- during the night or early in the morning, before inversion breakup and during the afternoon during the unstable conditions. Detailed profiles of wind speed and temperature will be obtained using a SODAR (Sound Detection And Ranging) system and its RASS (Radio Acoustic Sounding System) extension. The SODAR remotely sense the wind speed and turbulence statistics profiles in the lower atmosphere (15-1000m). RASS provides the temperature and sound speed profiles (both instruments are available for the ASU group). If surface measurements are needed (< 15m), tethered balloons can be employed. The deliverables of the project are: (i) All temperature, velocity and humidity data in the required forms; (ii) Plots showing the effects of inversions on sound propagation – a manual of results; (iii) Analysis of results; (iv) Final report detailing the procedure, uncertainties, analysis, results and inferences.

EXPECTED IMPLEMENTATION

The results will be melded with ADOT sound monitoring data.

STATUS OF THE RESEARCH

The draft final report is being reviewed.

Materials and Construction

TECHNICAL ADVISORY COMMITTEE (TAC)

Christ Dimitroplos	ATRC; M&C Project Manager; Champion;
Larry Scofield	AZ Concrete Pavement Association (ACPA);
Tom Kombe	ATRC, Environmental Project Manager;
Fred Garcia	ADOT, Environmental Group
Hugh Saurenman	ATS Consulting

SPR-606, *Implementation of the Mechanistic-Empirical (M-E) Design Guide for Arizona*

Research Agency:	ASU	FY Authorization:	2006
Principal Investigator(s):	Witczak	Contract Date:	9/19/09
Contract Amount:	$350,000	Sched. Completion Date:	Fall 2009
Program Budget:	$350,000	Est. Completion Date:	Fall 2009
Expenditures to date:	$124,000	Is project on schedule?	Yes
Available Amount	$226,000	ADVANTAGE No.	R060618P
Percent complete through 06/30/05	30%	Responsible ATRC Staff: (Project Manager)	Christ Dimitroplos

PROBLEM STATEMENT

To complete the final phase of current Project SPR-402: Implementation of the Mechanistic-Empirical Design Guide for Arizona.

Task 1- Accurately calibrate the pavement performance models to local field conditions.
Task 2 - How to implement the Mechanistic-Empirical Design Guide for pavement design and performance prediction in Arizona.
Task 3- Develop a framework for performance related specifications for Arizona.

RESEARCH OBJECTIVES

To calibrate pavement performance models to local conditions using Arizona field data. The result will enable ADOT to utilize the M-E Design Guide and develop a framework for Pavement Performance related specifications.

EXPECTED IMPLEMENTATION

The overall assessment of the utility of the Mechanistic Empirical Design Guide calibrated for Arizona materials and conditions. Framework for pavement performance related specifications for Arizona.

STATUS OF THE RESEARCH

The project has not begun.

TECHNICAL ADVISORY COMMITTEE (TAC)

Jim Delton ADOT Materials
Julie Nodes ADOT Materials
Paul Burch ADOT Materials
Bill Hurguy ADOT Materials
Christ Dimitroplos ATRC,
Tom Deitering FHWA
Private Industry.

SPR-630, *Critical Review of ADOT's Hot Mix Asphalt Specifications*

Research Agency:	Nichols Consulting	FY Authorization:	2007
Principal Investigator(s):	Dale Decker	Contract Date:	7/20/07
Contract Amount:	$69,000	Sched. Completion Date:	Pending
Program Budget:	$69,000	Est. Completion Date:	Pending
Expenditures to date:	$ 0	On schedule?	
Available Amount:	$69,000	ADVANTAGE No.	R063019P
Percent complete Through 6/30/08	0%	Responsible ATRC Staff: (Project Manager)	Christ Dimitroplos

PROBLEM STATEMENT

The Hot Mix Asphalt (HMA) industry has undergone significant changes in recent years. Changes include technological advancements in the equipment for the production and placement of HMA; changes in material availability; increased environmental regulation; and, changes in mix design criteria and procedures. ADOT's HMA specifications have not always kept pace with these changes and may potentially include requirements that increase the cost of HMA without any improvement in quality. Specification conformance data collected by the Construction Operations Group indicate very low conformance with some specification provisions, which may be a result of specifications that need revision.

RESEARCH OBJECTIVES

1. Review the state of the industry in Arizona with a focus on equipment and technologies currently being used or being considered for use in the production and placement of HMA.

2. Review the Construction Operations Groups specification conformance history for HMA and make recommendations on the probable cause of low conformance items (for example the specification needs to be revised, the specification needs to be better enforced).

3. Prepare a critical review of relevant ADOT HMA Specifications (Chapters 403, 406, 407, 409, 411, 413, 414, 415, 416, and 417) especially as they relate to equipment requirements. Recommend HMA specification changes.

EXPECTED IMPLEMENTATION

Reduction in disputes related to HMA specifications. The results of this research should also lead to improved conformance with HMA specifications.

STATUS OF THE RESEARCH

The Project has just begun.

TECHNICAL ADVISORY COMMITTEE (TAC)

Chad Auker – ADOT
Paul Burch – ADOT Materials
James Carusone – Hanson Materials
Jim Delton – ADOT Materials
Jon Epps – Granite Construction
Julie Gadsby – ADOT
Adrian Green – Vulcan Materials
Brian Gallimore – Markham Contracting
Bill Humphrey - ADOT HDR
Tom Kennedy – FNF Construction
Julie Kliewer – ADOT – Project Sponsor
Amanda McGennis – AGC – Project Champion
Bob McGennis – Holly Asphalt
Tom Deitering - FHWA
Sharon Gordon - FHWA

SPR-631, *Evaluate Warm Mix Technology for use in Asphalt Rubber – Asphaltic Concrete Friction Courses (AR-ACFC)*

Research Agency:	ASU	FY Authorization:	2007
Principal Investigator(s):	Dr. Witczak	Contract Date:	8/17/07
Contract Amount:	$150,000	Sched. Completion Date:	Pending
Program Budget:	$150,000	Est. Completion Date:	N/A
Expenditures to date:	$0	On schedule?	N/A
Available Amount:	$150,000	ADVANTAGE No.	R063119P
Percent complete Through 6/30/08	20	Responsible ATRC Staff: (Project Manager)	Christ Dimitroplos

PROBLEM STATEMENT

European countries are using technologies that allow a reduction in the temperatures at which asphalt mixes are produced and placed. These technologies have been labeled Warm Mix Asphalt (WMA). The immediate benefit to producing WMA is the reduction in energy consumption required by burning fuels to heat traditional hot mix asphalt (HMA) to temperatures in excess of 300° F at the production plant. With the decreased production temperature comes the additional benefit of reduced emissions from burning fuels, fumes, and odors generated at the plant and the paving site. The technology allows the production of WMA by reducing the viscosity of the asphalt binder at a given temperature. This reduced viscosity allows the aggregate to be fully coated at a lower temperature than what is traditionally required in HMA production. There have been a number of demonstration projects in the US with a variety of mixes and binders, but none with asphalt rubber.

RESEARCH OBJECTIVES

Conduct a two-phase project to evaluate the applicability of warm mix asphalt technology to ADOT's AR-ACFC mixes.

The first phase would be principally a laboratory evaluation and review of relevant literature designed to answer the following questions:

Are the existing WMA technologies compatible with the asphalt rubber binders used in ADOT's AR-ACFC mixes?

How does ADOT's design procedure for AR-ACFC mixtures need to be modified to accommodate WMA technologies?

The second phase would be primarily a field trial with the following research objectives:

- Characterize (quantify) the potential plant production / mix lay-down savings that can be generated by using WMA technologies in AR-ACFC (e.g. energy cost reduction, reduced emissions, etc.)
- Characterize the impact of incorporation WMA technologies into AR-ACFC mixes on the surface characteristics of the mix (e.g. noise reduction capabilities, frictional characteristics, and smoothness)
- Evaluate the potential for extension of the paving window for AR-ACFC resulting from reduced paving temperatures (e.g. minimum surface temperature, paving season)

EXPECTED IMPLEMENTATION

This research has the significant potential to reduce the plant production and placement costs due to decreases in energy costs. Materials Group will implement the findings in the form of revised specifications and test methods on future projects. Materials Group will implement any recommended changes to the AR-ACFC paving window (temperature and season).

STATUS OF THE RESEARCH

The Project has not yet begun.

TECHNICAL ADVISORY COMMITTEE (TAC)

Sharon Gordon	FHWA
Thomas Deitering	FHWA
John Shi	MCDOT
Scot Weinland	ADOT
Paul Burch	ADOT
Javed Bari	ADOT
Bob McGennis	Holly Asphalt
Julie Kliewer	ADOT
Joe Phillips	AMEC
Don Green	Cemex

SPR-633, *Economical Concrete Mix Designs Utilizing Blended Cements, Performance Based Specifications, and Rational Pay Factors*

Research Agency:	ASU	FY Authorization:	2007
Principal Investigator(s):	Dr. Mobasher	Contract Date:	7/08/08
Contract Amount:	Pending	Sched. Completion Date:	Pending
Program Budget:	$120,000	Est. Completion Date:	N/A
Expenditures to date:	$0	On schedule?	N/A
Available Amount:	$120,000	ADVANTAGE No.	R063319P
Percent complete Through 6/30/08	0	Responsible ATRC Staff: (Project Manager)	Christ Dimitroplos

PROBLEM STATEMENT

There is a need to contain the escalating costs of construction projects through the use of economical concrete materials and rational acceptance criteria. This is a proposal to increase competitiveness among project bidders by improving the procedures for materials selection, specifications, and also pay factors for contract administration. A preliminary study conducted for joint ADOT/ARPA committee has indicated that there are significant potential cost savings through the reduction of minimum specified cement content in various grades of concrete. Such reductions however must be accomplished so that the performance of final product is not jeopardized. This project will utilize and evaluate recent advances in performance enhancing mineral admixtures and supplementary cementitious materials, in addition to QC parameters used for specification and acceptance criteria in order to develop economical concrete mixtures.

RESEARCH OBJECTIVES

Promote better quality and economics of using concrete materials by focusing on:

1. Mix design formulation based on economy, superior performance, quality control, and durability.
2. Better utilization of mineral admixtures such as flyash through reducing the minimum cement requirements for 2500 psi and 3000 psi concrete mixtures.
3. Evaluation of the acceptance criteria and pay factor adjustment methods based on a bonus/penalty factors in improving quality control and specification procedures.

EXPECTED IMPLEMENTATION

Results can improve the quality of concrete construction in the State of Arizona while saving millions of dollars in construction costs. Historical ADOT data will be evaluated and calibrated against the proposed models that will be developed in this program. Special provisions will be developed and presented to the ADOT materials group. Specifications for new classes of concrete and their associated pay factors will be chosen. Testing and evaluation protocol for field trials as a follow up to this study will be identified.

STATUS OF THE RESEARCH

The Project has not begun

TECHNICAL ADVISORY COMMITTEE (TAC)

Not Assigned.

SPR-644, *Continuum Damage Theory applied for Asphalt Rubber Mixtures*

Research Agency:	ASU	FY Authorization:	2007
Principal Investigator(s):	Kaloush	Contract Date:	12/07/07
Contract Amount:	$25,000	Sched. Completion Date:	Pending
Program Budget:	$25,000	Est. Completion Date:	N/A
Expenditures to date:	$0	On schedule?	N/A
Available Amount:	$25,000	ADVANTAGE No.	R064419P
Percent complete Through 6/30/08	0	Responsible ATRC Staff: (Project Manager)	Christ Dimitroplos

PROBLEM STATEMENT

Recently, Continuum Damage Theory has been successfully applied in uniaxial fatigue tests for asphalt mixtures (Lee et. al ASCE, 2000). The relationship C-D (pseudo stiffness – Damage parameter) has been proven unique to each mixture, regardless of temperature, strain level, frequency, and type of loading (monotonic and cyclic). The results showed that developing this relationship C-D, reduced the number of fatigue tests necessary to evaluate asphalt mixtures. Furthermore, with simple formulation, fatigue life may be predicted knowing both the viscoelastic properties and the damage parameter. Using the same approach, fatigue tests with rest periods may be used to characterize mixtures with regards to the healing process. Continuum Damage Theory will likely be included in future revised pavement design numerical code, such as the Mechanistic Empirical Pavement Design Guide (MEPDG). Since no work in this area included asphalt rubber mixtures, a realistic model to characterize such fatigue behavior is needed.

Both ADOT and ASU have been focusing on characterizing asphalt rubber mixtures based on their unique behavior. A continuum damage approach assessment will potentially reduce the time consuming process of conducting many flexural beam fatigue tests in the laboratory.

RESEARCH OBJECTIVES

The main objective of this study is to evaluate the possibility of applying and comparing results of the above Continuum Damage Theory to Asphalt Rubber Mixtures using two types of tests available at ASU: Beam and Uniaxial Fatigue Tests.

The tasks required are:

1. Brief documentation of the continuum damage theory;
2. Conduct analysis using this new approach on beam fatigue tests data already available in the ASU database from previous ADOT mixtures testing;
3. Conduct beam fatigue tests on ADOT asphalt mixtures, using the traditional (currently being done) and the new approach;
4. Perform uniaxial fatigue tests on ADOT conventional and asphalt rubber mixtures (new testing in this study)
5. Analyze the results, provide a comparative analysis and submit a fully explanatory and well-documented final report that incorporates the findings of tasks 1 through 4.

EXPECTED IMPLEMENTATION

It is expected that the study will result in a possibility to implement those mixtures characteristics in the new MEPDG in the future.

STATUS OF THE RESEARCH

The Project has not begun

TECHNICAL ADVISORY COMMITTEE (TAC)

Project Champion: Dr. Julie Kliewer

Project Sponsor: Jim Delton

Proposed Technical Advisory Committee: TBD

SPR-656, ***Asphalt Rubber Mixtures Susceptibility to Moisture Damage***

Research Agency:	ASU	FY Authorization:	2008
Principal Investigator(s):	Kaloush	Contract Date:	12/07/07
Contract Amount:	$25,000	Sched. Completion Date:	Pending
Program Budget:	$25,000	Est. Completion Date:	N/A
Expenditures to date:	$0	On schedule?	N/A
Available Amount:	$25,000	ADVANTAGE No.	R065620P
Percent complete Through 6/30/08	0	Responsible ATRC Staff: (Project Manager)	Christ Dimitroplos

PROBLEM STATEMENT

Between 1989 and 2004, a total of 135 projects were constructed using the asphalt rubber gap graded asphalt rubber-asphalt concrete (ARAC) mix totaling 3521 lane miles. The performance of these mixes has been excellent. However, in 2004, four projects suffered from premature failure and developed rutting, shoving and washboard within one year of construction. Field observation and forensic evaluations indicated that stripping / moisture damage may have been the cause of this premature failure. Currently, there are no standards or laboratory test data in Arizona to support the knowledge area on the susceptibility of asphalt rubber mixtures to moisture damage. There is a need to develop acceptance limits / criteria for asphalt rubber mixtures to guard against possible moisture damage in the field.

RESEARCH OBJECTIVES

The objective of this study is to identify if any of the recent laboratory tests implemented in the pavement community (Simple Performance Tests) are able to assess the susceptibility of asphalt rubber mixtures to moisture damage. Of particular interest, whether the evaluation of the AASHTO T 283 Modified Lottman moisture susceptibility test can be successfully applied.

The tasks required are:

1. Brief literature documentation on moisture damage and test procedures;
2. Conduct laboratory testing program on asphalt rubber-asphalt concrete friction course (AR-ACFC), ARAC, and conventional HMA mixes using AASHTO T 283 to determine the indirect tensile strength and percent retained strength.
3. Conduct similar tests as in task 2 but using the E* dynamic modulus to determine the percent retained strength.
4. Using the Mechanistic-Empirical Pavement Design Guide (MEPDG) software, simulate the stripping problem in the field using reduced moduli (E*) and examine the impact on rutting development.
5. Analyze the results, provide a comparative analysis and submit a fully explanatory and well-documented final report that incorporates the findings of tasks 1 through 4.

EXPECTED IMPLEMENTATION

This research will provide the first step toward the development of a mix design acceptance criteria for asphalt rubber mixtures to protect against moisture damage.

STATUS OF THE RESEARCH

The Project has not begun

Materials and Construction

TECHNICAL ADVISORY COMMITTEE (TAC)

Project Champion: Dr. Julie Kliewer

Project Sponsor: Jim Delton

Proposed Technical Advisory Committee: TBD

SPR-658*, Performance Testing of HPC on the Sunshine Bridge Project*

Research Agency:	JEC	FY Authorization:	2008
Principal Investigator(s):	Tarif Jaber	Contract Date:	12/06/07
Contract Amount:	Pending	Sched. Completion Date:	Pending
Program Budget:	$25,000	Est. Completion Date:	N/A
Expenditures to date:	$0	On schedule?	N/A
Available Amount:	$25,000	ADVANTAGE No.	R065820P
Percent complete Through 6/30/08	0	Responsible ATRC Staff: (Project Manager)	Christ Dimitroplos

PROBLEM STATEMENT

The purpose of this project is to perform testing of the Sunshine Overpass Bridge on I-40 and confirm the performance of the bridge deck and the High Performance Concrete. This bridge deck was replaced in August 2005 as a pilot project conducted by the Arizona Department of Transportation (ADOT) to evaluate the feasibility of using High Performance Concrete (HPC) technology (project SPR-538). The project consisted of replacing a cast-in-place concrete deck slab with durable HPC deck. The HPC was designed for durability under freeze-thaw exposure, lower permeability to salt penetration, lower shrinkage potential, and reduced steel corrosion. Quality control and quality assurance programs were followed during construction to collect and document information regarding properties of the concrete. Although testing was performed during construction, no in-place properties were measured after construction. The purpose of this follow-up testing will be to confirm the properties that were anticipated from the QC and QA testing. The work needs to be carried out for a reasonable amount of time (approximately 5 years—testing will be performed 2 or 3 times depending on the initial test results) until there is no significant change in the test values. The monitoring program will:

1. Establish a baseline for performance – test the concrete in the field to establish reference point.
2. Test periodically to measure against the established baseline and the anticipated properties.

The monitoring program will consist of:

1. Visual examination of the bridge deck and barriers to document any cracking. If cracking is found, need to identify the type and cause so it can be addressed in the next HPC project.
2. Take concrete cores from selected locations on the deck for permeability testing, chloride Ion content and perform petrographic examination to document concrete conditions. Cores will need to be taken at random locations going no more than 3-4” into the deck without hitting steel.
3. Measure the extent of chloride penetration through the bridge deck by collecting concrete powder samples at 1” depths. This is a very important field measure of how well concrete is preventing chloride travel through the concrete and toward the steel.
4. Collect environmental and service data such as: salt application, snow falls, and temperature records to establish service conditions and compare against performance.

The list of laboratory tests required for the program include:

1. Rapid Chloride Permeability test
2. Air Void Analysis
3. Petrographic examination of concrete
4. Chloride Ion content.

RESEARCH OBJECTIVES

This research project will provide ADOT with the actual performance results from our initial attempt at constructing a durable HPC bridge deck. ADOT is in the process of creating specifications for HPC and this information will either confirm the performance of the HPC placed two years ago or suggest further avenues for improvement. If testing shows better performance is needed in our HPC, modified specifications will need to be developed.

EXPECTED IMPLEMENTATION

The results of this project will be used by the Materials Group and Bridge Group in creating and updating ADOT's HPC specifications. These specifications will be designed to provide a longer service life for the bridge decks that are be constructed on ADOT projects.

STATUS OF THE RESEARCH

The Project has not begun

TECHNICAL ADVISORY COMMITTEE (TAC)

Project Champion: Chad Auker, Materials Group

Project Sponsor: Jim Delton, Materials Group

Proposed Technical Advisory Committee:

Paul Sullivan, Materials Group

Ken Roberts, Materials Group

Bridge Group Representative

Aryan Lirange, FHWA

SPR-661, *Engineering Design Methods to Mitigate Damages from Earth Fissures*

Research Agency:	Uof A	FY Authorization:	2008
Principal Investigator(s):	Dr. Budhu	Contract Date:	6/10/08
Contract Amount:	Pending	Sched. Completion Date:	Pending
Program Budget:	$25,000	Est. Completion Date:	N/A
Expenditures to date:	$0	On schedule?	N/A
Available Amount:	$25,000	ADVANTAGE No.	R066120P
Percent complete Through 6/30/08	0	Responsible ATRC Staff: (Project Manager)	Christ Dimitroplos

PROBLEM STATEMENT

Earth fissures have been observed over the past 60 years in Arizona but they have only become a public concern over the last decade with the rapid growth in the metro areas of Phoenix and Tucson. Engineering practice in siting transportation systems in areas where earth fissures are visible is to avoid them. This practice is no longer tenable because of high density developments, rights to right of ways, environmental concerns and skyrocketing land values. In addition, there is no established knowledge base to warn an engineer that an earth fissure would likely develop in an existing or a planned transportation system corridor. What design or mitigation measures should an engineer take when a transportation system crosses an earth fissure? Engineers desperately need an answer and have recently implemented some mitigation measures such as bridging (Central Arizona Project canal, Loop 202 Red Mountain Freeway), backfilling (Santan Mountains area), and replacing threatened structural segments (McMicken Dam). It is unknown whether these measures are appropriate and whether the structures will perform satisfactorily over their design life.

RESEARCH OBJECTIVES

A literature survey and an evaluation of the materials and methods that have been used to mitigate damage and retrofitting transportation systems due to earth fissures.

EXPECTED IMPLEMENTATION

The research will be implemented through planning, engineering design and construction procedures to be adopted by ADOT based on the research findings.

STATUS OF THE RESEARCH

The Project has not begun

TECHNICAL ADVISORY COMMITTEE (TAC)

Project Champion: Jim Wilson
Project Sponsor: John Lawson
Proposed Technical Advisory Committee: ADOT Geotech, Arizona Transportation Research Center, Roadway Design

SPR-672*, Development of a Traffic Data Input System in Arizona for the Mechanistic Empirical Pavement Design Guide*

Research Agency:	Pending	FY Authorization:	2009
Principal Investigator(s):	Pending	Contract Date:	Pending
Contract Amount:	Pending	Sched. Completion Date:	Pending
Program Budget:	$150,000	Est. Completion Date:	N/A
Expenditures to date:	$0	On schedule?	N/A
Available Amount:	$150,000	ADVANTAGE No.	R067221P
Percent complete Through 6/30/08	0	Responsible ATRC Staff: (Project Manager)	Christ Dimitroplos

PROBLEM STATEMENT

In the next five years, the Arizona Department of Transportation (ADOT) will spend 6.5 billion dollars in its highway construction program. A significant portion of that money will be used for the highway pavement structures. Traffic data is one of the key data elements required for the design/analysis of all pavement structures. Currently, the only traffic data available to the Pavement Design Section for designing Arizona pavements are: (i) Annual Average Daily Traffic (AADT) obtained from the Multimodal Planning Division, and (ii) Equivalent Single Axle Load (ESAL) data predicted by the Pavement Management Section. It is noteworthy that the prediction is based on the statewide traffic survey completed in 1997, which was started in 1995. Since the current predictions are based on a very old survey, it is very important that new regular data collection and periodic traffic surveys be conducted. As ADOT is getting ready to adopt the new Mechanistic Empirical Pavement Design Guide (MEPDG), the old survey data will become incompatible with the new design protocols. The MEPDG requires a major change in the way ADOT has been acquiring and compiling the traffic data. For example, the MEPDG uses traffic load spectra data instead of calculating ESALs. Therefore, it is imperative that ADOT has a comprehensive traffic data input system.

RESEARCH OBJECTIVES

1. Identify the needs of various sections within ADOT in terms of traffic data specifically related to the American Association of State, Highway and Transportation Officials (AASHTO) 1993 Pavement Design Guide and the new MEPDG.
2. Evaluate the current ADOT practice in terms of obtaining, compiling and managing traffic data.
3. Critically investigate into the existing traffic data collection infrastructures, such as weigh in motion (WIM) stations, and determine their validity and usefulness for use with the MEPDG.
4. Develop a detailed action plan for ADOT to continuously obtain all necessary traffic data and compile that information for effective use in the MEPDG. The action plan should also include a detailed cost estimate.

EXPECTED IMPLEMENTATION

Implementation will require changes in the work done by the Data Team in MPD and changes in the final product they provide to the Materials group. Implementation would be in stages as the MEPDG is incorporated into our Pavement Design and Management processes.

STATUS OF THE RESEARCH

The Project has not begun

TECHNICAL ADVISORY COMMITTEE (TAC)

Burch, Javed Bari, Ron Fregin, Douglas Eberline, Tom Deitering – FHWA

SPR-673*, Performing Lifecycle Cost Analysis of HPC and Developing HPC Specifications for ADOT Bridge Projects*

Research Agency:	Pending	FY Authorization:	2009
Principal Investigator(s):	Pending	Contract Date:	Pending
Contract Amount:	Pending	Sched. Completion Date:	Pending
Program Budget:	$175,000	Est. Completion Date:	N/A
Expenditures to date:	$0	On schedule?	N/A
Available Amount:	$175,000	ADVANTAGE No.	R067321P
Percent complete Through 6/30/08	0	Responsible ATRC Staff: (Project Manager)	Christ Dimitroplos

PROBLEM STATEMENT

Using High Performance Concrete (HPC) on bridge decks has been found to improve concrete quality, extend service life of the structure and reduce maintenance. Many state agencies have used HPC on bridges and have developed special specifications for implementing HPC. While there might be an increase in construction cost for using HPC on bridge projects, a lifecycle cost analysis is needed to evaluate and confirm the cost benefits of using HPC local materials and technology on Arizona bridge projects.

Successful implementation of HPC on bridges requires proper specification of materials and technology. The Arizona Department of Transportation (ADOT) currently does not have a specification to facilitate the successful implementation of HPC on bridges. ADOT uses HPC materials on bridge deck repair projects, but the current specification lacks the technology and the provisions to make sure HPC implementation is carried out properly and HPC benefits are achieved.

RESEARCH OBJECTIVES

1. Provide ADOT with lifecycle cost analysis needed to evaluate the benefits of using HPC on bridge projects in Arizona in hot and arid climates and under various exposure conditions found in Arizona.
2. Develop a stand-alone special provision prescriptive specification for HPC bridge decks. ADOT will use this specification to implement HPC on bridge projects in Arizona.
3. Provide an interim performance specification for use on future ADOT bridge projects. Data collected and experience gained from implementing HPC on upcoming bridge projects using prescriptive specifications will help ADOT update and finalize this interim performance specification.

EXPECTED IMPLEMENTATION

1. Meet with the Technical Advisory Committee (TAC) to discuss and confirm the scope of work and action plan.
2. Perform lifecycle cycle cost analysis to assess the economic feasibility and rate of return for using local construction and material to implement HPC on bridges in Arizona.
3. Develop a prescriptive specification for implementing HPC using ADOT specification formats.
4. Develop an interim performance specification for future implementation of HPC.

5. The results from tasks 2 and 3 will be presented to TAC for review and approval.
6. A final report will be presented that includes:
    a. A lifecycle cost analysis
    b. A special provision HPC specification.
    c. HPC guidelines, proposed test methods and acceptance limits.

STATUS OF THE RESEARCH

The Project has not begun

TECHNICAL ADVISORY COMMITTEE (TAC)

Paul Sullivan and Gregg Inman (Materials Group), Shawn Farahzadi (Construction Group), Pe-Shen Yang (Bridge Group), Aryan Lirange (FHWA)

SPR-674, *Engineering Properties of Recycled ARFC Overlays*

Research Agency:	Pending	FY Authorization:	2009
Principal Investigator(s):	Pending	Contract Date:	Pending
Contract Amount:	Pending	Sched. Completion Date:	Pending
Program Budget:	$75,000	Est. Completion Date:	N/A
Expenditures to date:	$0	On schedule?	N/A
Available Amount:	$75,000	ADVANTAGE No.	R067421P
Percent complete Through 6/30/08	0	Responsible ATRC Staff: (Project Manager)	Christ Dimitroplos

PROBLEM STATEMENT

Many existing Asphalt Rubber Friction Course (ARFC) overlays are reaching the end of their life cycle, which will necessitate their replacement in the coming years. An option to reduce the costs associated with replacement would be to recycle the existing material and reuse it in future ARFC overlay projects. However, the performance characteristics of the recycled ARFC are unknown.

RESEARCH OBJECTIVES

The goal of this study will be to develop an experimental laboratory program to obtain typical engineering properties of the recycled ARFC mixes and compare them to conventional ARFC mixes. The tasks required for the successful completion of this study are:

1. Identify an Arizona Department of Transportation (ADOT) recycling ARFC project, and develop a detailed work plan.
2. Sample the mix during construction and bring back to Arizona State University laboratories. Laboratory specimens will be prepared and subjected to typical ADOT-ASU testing program. The tests will include: triaxial shear strength, dynamic modulus, static creep and repeated load for permanent deformation characterization; indirect tensile creep test for thermal cracking; and flexural beam tests for fatigue and fracture cracking evaluation.
3. Analyze results and compare them with conventional ARFC mixtures test data.
4. Conduct field performance evaluation.
5. Provide a summary report of the laboratory and field findings; present the findings at a technical advisory committee meeting.

EXPECTED IMPLEMENTATION

The results of this study could be used immediately for the future design of recycled ARFC mixes.

STATUS OF THE RESEARCH

The Project has not begun

TECHNICAL ADVISORY COMMITTEE (TAC)

Not yet assigned

Planning and Administration – PROJECTS

SPR-535, *Commercial Vehicle Information Systems Network (CVISN) Safety Information Exchange Needs Assessment for the Nogales Port-of-Entry*

Phase 1

Research Agency:	Booz Allen Hamilton	FY Authorization:	2005
Principal Investigator(s):	Taso Zografos	Contract Date:	07/26/02
Contract Amount:	$145,000	Sched. Completion Date:	12/31/03
Program Budget:	$145,000	Actual Completion Date:	05/31/04
Expenditures to date:	$145,000	On schedule?	Yes
Available Amount:	0	ADVANTAGE No.	R053517P
Percent complete Through 6/30/08	100% (phase 1)	Responsible ATRC Staff: (Project Manager)	John Semmens

Phase 2

Research Agency:	Data Methods	FY Authorization:	2006
Principal Investigator(s):	Robert Done	Contract Date:	11/03/04
Contract Amount:	$14,820	Sched. Completion Date:	12/31/08
Program Budget:	$240,458	Estimated Completion Date:	12/31/08
Expenditures to date:	$98,058	On schedule?	Yes
Available Amount:	$142,400	ADVANTAGE No.	R053518P
Percent complete through 6/30/08	95% (phase 2)	Responsible ATRC Staff: (Project Manager)	Frank Darmiento

PROBLEM STATEMENT

Various federal and state motor carrier safety information systems are now available, but are not installed nor being used at the Nogales Cargo Port. This hampers the ability for all commercial vehicle safety inspectors to capture, communicate and collect data pertinent to vehicles and drivers they are examining. The inability of truck inspectors to have immediate access to required records may lead to potential accidents or allow problem drivers to operate vehicles.

The state and federal governments are developing a multi-million dollar inspection facility at Nogales. The lack of timely vehicle and driver information will have an impact on the facility operating at full potential.

A Commercial Vehicle Information Systems Network (CVISN) will provide Arizona and federal truck inspectors with an excellent means to use available technology to obtain and exchange driver and vehicle records, both with Mexican and US authorities, especially as they relate to Motor Carrier Safety and crash history. A Commercial Vehicle Information Systems Network is another smart technology enhancement that will make easier law enforcement's job of making highways safer for the motoring public and preserving the transportation infrastructure.

RESEARCH OBJECTIVE

Evaluate the specific needs in terms of a safety information exchange system under the umbrella of a Commercial Vehicle Information Systems Network and intelligent transportation systems related technologies.

EXPECTED IMPLEMENTATION

The research outcome will help identify how the Arizona Department of Transportation, along with the Department of Public Safety and U.S. Department of Transportation, can enhance their collective motor carrier safety objectives. These successful accomplishments will lead to safer vehicles, safer drivers and an overall safer highway transportation environment, with an attendant drop in highway crashes and a decrease in resultant injuries and fatalities. The Motor Vehicle Division of the Arizona Department of Transportation will be the process owner.

STATUS OF THE RESEARCH

Phase 1 has been completed. Phase 2 draft final report under review.

TECHNICAL ADVISORY COMMITTEE (TAC)

Sponsor & Champion: George N. Bays, MVD
Statewide Project Mgt.: David Mellgren
GSA, Desert Service Center: Robert Blanchard
US Customs & Border Protection: Armando Goncalvez
Dept of Public Safety: Lt. Terry DeBoer
MVD: Ric Athey
FHWA: Jennifer Brown and Ed Stillings
ATRC:

SPR-547, *Arizona Statewide Safety Project Analysis Model*

Research Agency:	ATRC	FY Authorization:	2005
Principal Investigator(s):	Zachary Slocum	Contract Date:	08/30/02
Contract Amount:	$14,000	Sched. Completion Date:	05/31/09
Program Budget:	$16,000	Estimated Completion Date:	05/31/09
Expenditures to date:	$709	On schedule?	No
Available Amount:	$15,291	ADVANTAGE No.	R054717P
Percent complete through 6/30/08	20%	Responsible ATRC Staff: (Project Manager)	Jason Harris

PROBLEM STATEMENT

In June 2001, the Arizona Transportation Research Center (ATRC) completed a research project in which a model was developed for evaluating prospective safety projects on local government streets and roadways. This model enables the user to identify high crash locations based on total crashes, fatalities, and aggregate cost of crashes. Further, the model then permits the user to compare benefit/cost ratios for prospective safety improvements. The result is a tool that assists local governments in selecting the most cost-effective means for remedying the worst crash locations.

This proposed project would adapt the previously developed model to include State Highways in the database. This would enable a more comprehensive safety analysis of all roadways in Arizona. Users of the model would be able to identify and propose remedies for the worst crash sites regardless of the jurisdiction controlling the sites. Safety project investments could be optimized across jurisdictional boundaries and drivers in Arizona would enjoy the maximum pay-off in terms of reduced crash costs per dollar of investment no matter where they travel in the state.

RESEARCH OBJECTIVES

The existing database model will be enhanced to accommodate a statewide, multi-jurisdictional perspective.

EXPECTED IMPLEMENTATION

The research will result in a report and model that can be used by state and local governments to more effectively evaluate potential safety projects. The process owner would be the Multimodal Planning Division, ADOT.

STATUS OF THE RESEARCH

New researcher hired. New focus on web-based interface underway.

Planning and Administration

TECHNICAL ADVISORY COMMITTEE (TAC)

Sponsor: Jami Garrison--Multimodal Planning Division
Champion: Larry Talley--Multimodal Planning Division
Governor’s Traffic Safety Advisory Council: Michael Hegarty
ADOT Traffic: Kohinoor Kar & Reed Henry
ADOT ITG: Doanh Bui
ADOT MVD: Rick Turner
TRA: Jason Carey
ADOT Risk Management: Cindy Eiserman
FHWA: Jennifer Brown
ATRC: Jason Harris

SPR-571, *Options for Reducing ADOT's Legal Liability Costs*

Research Agency:	Bickmore Risk Services	FY Authorization:	2004
Principal Investigator(s):	Sandra Spiess & Mark Priven	Contract Date:	06/01/2007
Contract Amount:	$40,000	Scheduled Completion Date:	10/31/2008
Program Budget:	$40,000	Estimated Completion Date:	10/31/2008
Expenditures to date:	$12,600	Is project on schedule?	yes
Available Amount:	$27,400	ADVANTAGE No.	R057116P
Percent complete through 6/30/08	90%	Responsible ATRC Staff: (Project Manager)	Frank Darmiento

PROBLEM STATEMENT

The costs of litigation related to a variety of transportation operations is often an unanticipated cost. One major factor in the determination of legal cost is clearly an aspect of safety and how safe the facilities are technically as well as legally. Safety concerns are paramount in the design construction and operation of highway systems and related legal suits

The condition: It is not only the technical safety that brings about costs to the transportation system, but the perceived safety conditions that are subjected to legal suits that need definition. Assessing the magnitude and identifying means by which these amounts could be reduced may not only create major savings, but also lead to adjustments in the administrative operations that will reduce litigation and liability costs.

RESEARCH OBJECTIVES

1. First it is proposed to determine the annual average cost of legal liability currently compared to other DOTs nationally. Research the practices and policies that provide results that bring about less liability costs. It is proposed to define the reasons for and category of the liability losses.
2. Analyze legal options and define methods and means for the most cost efficient methods of reducing liability and settling lawsuits.
3. Obtain recommendations for policy changes, law requirement or resource needs.

ANTICIPATED BENEFITS

The results of such an inventory and definition of the magnitude might identify a variety of options: that more resources (lawyers) are needed to provide legal defense; that the basis for settlement of claims may need different parameters or measure, that added preparation technically could avert major legal costs or that the ADOT stands in the lead of national statistics for saving transportation funds in settlement of claims and litigation cases.

The annual cost of settlements of legal claims is about 12 million dollars annually.
Even a 10% reduction in loses would save over $1,000,000.

EXPECTED IMPLEMENTATION

ADOT Risk Management will use the research findings to help reduce tort losses. This may involve a request for revisions to Arizona tort law.

STATUS OF RESEARCH

Draft final report under review.

TECHNICAL ADVISORY COMMITTEE (TAC)

Jim Redpath	ADOT Attorney General's Office
Cindy Eiserman	ADOT Risk Management
Liz Pence	Arizona Department of Administration
Doug Forstie	Deputy State Engineer
Karen King	FHWA
Sonya Herrera	ADOT Safety
Jason Harris	ATRC

SPR-583, *Open Source Software Study*

Research Agency:	ATRC	FY Authorization:	2004
Principal Investigator(s):	Sean Coleman	Contract Date:	03/27/07
Contract Amount:	$13,650	Sched. Completion Date:	05/31/09
Program Budget:	$15,000	Estimated Completion Date:	05/31/09
Expenditures to date:	$5,801	On schedule?	Yes
Available Amount:	$9,199	ADVANTAGE No.	R058016P
Percent complete through 6/30/08	35%	Responsible ATRC Staff: (Project Manager)	Frank Darmiento

PROBLEM STATEMENT

ADOT currently spends over 1 Million dollars annually for software licenses, software maintenance, and support contracts for software in the enterprise. This covers both software on the desktop and server software. Open source software (OSS) such as the Linux operating system, Apache web server, Sendmail mail server, Open Office office suite, etc are all examples of stable, secure, reliable, and free software packages which could possibly replace existing commercial off-the-shelf (COTS) software.

RESEARCH OBJECTIVES

1. Determine where open source software may fit into the ADOT enterprise to replace current COTS software or add new functionality not covered by existing software.
2. Examine the benefits and risks of using OSS vs. COTS software within ADOT.
3. Estimate cost savings (Direct and Indirect) of utilizing OSS software within ADOT.

EXPECTED IMPLEMENTATION

ATRC will conduct the research with the assistance of one or more university graduate students. ADOT management will decide whether to adopt a new software standard.

This research will give ADOT an understanding of the expected costs, benefits, and risks involved with implementing OSS in the enterprise. ADOT will gain experience in OSS through piloting one or more applications to better understand some of the intangibles involved. ITG will be the process owner.

STATUS OF THE RESEARCH

Pilot test planned.

TECHNICAL ADVISORY COMMITTEE (TAC)

Sponsor: Joe Throckmorton, ITG
Champion: Jamie Rybarczyk, ITG
FHWA: Karen King
ATRC:

SPR-613, *Quantifying the Impact of Opening a New Segment of Freeway*

Research Agency:	Arizona Transportation Research Center	FY Authorization:	2005
Principal Investigator(s):	Jeff McLellan	Contract Date:	04/25/2006
Contract Amount:	$12,000	Sched. Completion Date:	12/31/08
Program Budget:	$15,000	Estimated Completion Date:	12/31/08
Expenditures to date:	$10,260	On schedule?	Yes
Available Amount:	$4,740	ADVANTAGE No.	R061317P
Percent complete through 6/30/08	90%	Responsible ATRC Staff: (Project Manager)	Frank Darmiento

PROBLEM STATEMENT

We build and expand the capacity of urban freeways with the idea that they will help relieve urban street congestion. Critics contend that new freeways worsen congestion. What is needed is an examination of the impacts that new urban freeway segments have had on urban traffic. Using the Phoenix metropolitan region as a test case, data on traffic on adjacent and parallel city streets before and after the opening of new freeway segments or capacity additions could be used to quantify the changes resulting from the new facilities.

RESEARCH OBJECTIVES

1. Estimate and document the traffic impacts of new freeway segments in the Phoenix metropolitan region.
2. Determine whether the new freeways help relieve congestion.

EXPECTED IMPLEMENTATION

ADOT will use the information to improve the agency's reputation with the general public and elected officials.

The research will lay the groundwork for conveying the message of the cost-effectiveness of urban freeways for meeting urban travel needs. ADOT's Office of Strategic Management and Budget will be the process owner.

STATUS OF THE RESEARCH

Draft final report under review.

Planning and Administration

TECHNICAL ADVISORY COMMITTEE (TAC)

Sponsor: Matthew Burdick, Communications & Community Partnerships
Champion: John Carlson, MVD
MAG: Vladimir Livshits
ADOT Environmental: Thor Anderson
ADOT Traffic: Mike Manthey
Valley Project Mgt: Larry Langer
Acting State Engineer: Floyd Roehrich
FHWA: William Vachon
ATRC:

SPR-618, *Land Use and Traffic Congestion*

Research Agency:	Richard Kuzmyak	FY Authorization:	2006
Principal Investigator(s):	Richard Kuzmyak	Contract Date:	01/30/2007
Contract Amount:	$100,000	Sched. Completion Date:	12/31/2008
Program Budget:	$100,000	Estimated Completion Date:	12/31/2008
Expenditures to date:	$18,900	On schedule?	Yes
Available Amount:	$81,100	ADVANTAGE No.	R061818P
Percent complete through 6/30/08	30%	Responsible ATRC Staff: (Project Manager)	Dianne Kresich

PROBLEM STATEMENT

The way land is used affects the volume of traffic on the abutting streets. It is unclear whether sufficient attention is given to the traffic impacts of land use decisions. There is considerable controversy over whether the increased density would reduce or increase traffic congestion.

Better data on the relationship between land uses and traffic congestion could help us make better land use decisions. These better decisions could lead to reduced traffic congestion, improved air quality, and lower roadway infrastructure costs.

RESEARCH OBJECTIVES

1. Examine land use patterns and their contribution to mitigating or worsening traffic congestion.
2. Recommend options for policies that may be more conducive to reducing traffic congestion.

EXPECTED IMPLEMENTATION

The research will result in data indicating how different types of land use patterns contribute to traffic congestion and whether better decisions could lead to lessened traffic congestion. The Multimodal Planning Division of ADOT would be the process owner.

STATUS OF THE RESEARCH

The project is underway.

TECHNICAL ADVISORY COMMITTEE (TAC)

Champion & Sponsor:
MPD: Charlene Fitzgerald
PAG: Kristen Zimmerman
Surprise: Randy Overmyer
FHWA: Jermaine Hannon
ATRC: Dianne Kresich

SPR-623, *Increasing Vehicle Registration Compliance and Revenue through Proactive Identification*

Research Agency:	ATRC	FY Authorization:	2006
Principal Investigator(s):	Kate Ernzen	Contract Date:	01/29/2007
Contract Amount:	$15,000	Sched. Completion Date:	09/30/2008
Program Budget:	$15,000	Est. Completion Date:	09/30/2008
Expenditures to date:	$3,375	On schedule?	yes
Available Amount:	$11,625	ADVANTAGE No.	R062318P
Percent complete through 6/30/08	95%	Responsible ATRC Staff: (Project Manager)	Frank Darmiento

PROBLEM STATEMENT

Arizona Revised Statutes 28-2153 requires that vehicles be appropriately registered. There is no grace period for new residents who have current but out-of-state vehicle registrations. ADOT estimates that several million dollars *per year* are lost because of unregistered vehicles belonging to new residents. This loss is likely to increase as Arizona's population continues to grow through migration.

Currently, registration compliance is achieved through self-identification and enforcement efforts. Given the magnitude of lost revenue per year, neither of these alternatives is adequately effective. Another alternative, one that proactively identifies individuals who are likely to need Arizona vehicle registration, is needed.

An efficient and effective method to identify these individuals is to reference new residential utility activations. In rental units the water service is often paid for by the landlord; and not every residence, especially those built in the 1970s, has gas service. But practically every residence has electric service. Although electric service records will not capture every new resident (e.g., some rentals include the cost of all utilities), it is the best alternative available. Thus, new residential electric service activations provide an effective basis for identifying and informing residents of the need and process to fulfill Arizona vehicle registration requirements.

RESEARCH OBJECTIVES

1. Develop a data sharing prototype process with electric utility companies in a major metropolitan area to proactively identify new residents.
2. Determine the cost effectiveness of implementing the data sharing process on a statewide basis.

EXPECTED IMPLEMENTATION

The research will result in a data sharing prototype that may allow ADOT to significantly increase vehicle registration compliance and revenue. ADOT MVD will be the process owner.

STATUS OF THE RESEARCH

Draft final report under review.

Planning and Administration

TECHNICAL ADVISORY COMMITTEE (TAC)

Sponsor: Stacey Stanton
Champion: George Lamb
MVD Enforcement: John Morales, Robert Bishop, Travis Legere
PAG: Robert Done
FHWA: Karen King
ATRC:

SPR-636, *"Heat Island" Effect of Pavements*

Research Agency:	Arizona State University	FY Authorization:	2007
Principal Investigator(s):	Jay Golden & Kamil Kaloush	Contract Date:	01/19/2007
Contract Amount:	$50,000	Sched. Completion Date:	09/30/2008
Program Budget:	$50,000	Est. Completion Date:	09/30/2008
Expenditures to date:	$9,000	On schedule?	yes
Available Amount:	$41,000	ADVANTAGE No.	R063619P
Percent complete through 6/30/08	90%	Responsible ATRC Staff: (Project Manager)	Christ Dimitroplos

PROBLEM STATEMENT

Current methods to pave roadways and parking lot surfaces have an unintended, and often undesired effect of raising the ambient temperature in the area. Dense urbanized area can see increases in sub-zones sufficient enough to raise health concerns for the elderly and very young as well as increase energy costs for cooling building interiors. New technologies could offer other solutions to paving surfaces that might mitigate to some degree this effect. Once these alternative techniques are identified areas that suffer from a heat island effect could require the use of these new technologies to reduce and mitigate this effect.

RESEARCH OBJECTIVES

1. Estimate the "heat island" effect of various paved surfaces.
2. Recommend options for mitigating this effect.

EXPECTED IMPLEMENTATION

The research will provide data that could be used to mitigate "heat island" impacts of its paving activities. The ADOT Process owner would be the Multimodal Planning Division.

STATUS OF THE RESEARCH

Draft final report under review.

TECHNICAL ADVISORY COMMITTEE (TAC)

Sponsor & Champion: Cherie Campbell, PAG
ADOT Materials: Paul Burch
MPD: Beverly Chenausky
Environmental: Mark Hollowell
FHWA: Tom Deitering
ATRC: Christ Dimitroplos

SPR-640, *Cost-Effectiveness of Mobile Enforcement*

Research Agency:	Arizona Transportation Research Center	FY Authorization:	2006
Principal Investigator(s):	Uyen Tran	Contract Date:	03/06/2007
Contract Amount:	$15,000	Sched. Completion Date:	10/31/08
Program Budget:	$15,000	Estimated Completion Date:	10/31/08
Expenditures to date:	$3,037	On schedule?	Yes
Available Amount:	$11,963	ADVANTAGE No.	R062018P
Percent complete through 6/30/08	75%	Responsible ATRC Staff: (Project Manager)	Frank Darmiento

PROBLEM STATEMENT

Currently, MVD attempts to enforce weight limits and safety regulations for commercial vehicles through ports-of-entry and mobile details. It is the unanimous opinion of those charged with enforcement responsibility that this effort is under-funded. Yet, this opinion has been insufficient to persuade decision makers to increase the budget allocated to enforcement.

ADOT needs to do a study of the effectiveness of enforcement efforts. This particular study would focus on the mobile enforcement activities in order to determine if the benefits in terms of fines & fees collected, pavement damage avoided and crashes averted due to enforcement efforts exceed the costs of mobile enforcement details.

If we can quantify the benefits and costs per unit enforcement effort, we can establish an optimal level of effort. The purpose of this study would be to examine the costs of mobile enforcement details and compare them to the estimated impacts in terms of revenues gained, costs avoided and crashes averted directly resulting from the enforcement effort.

RESEARCH OBJECTIVES

1. The researcher will review the existing literature on mobile enforcement to assess the current state-of-the-practice.
2. With the assistance of the ATRC, the researcher will conduct a survey of other transportation agencies to ascertain whether they have ascertained benefit/cost relationships for their mobile enforcement efforts.
3. The researcher will examine data from a representative sample MVD mobile enforcement details in order to estimate costs vs. benefits.

EXPECTED IMPLEMENTATION

It is expected that the study results will help guide MVD and ADOT to implement a more cost-effective mobile enforcement program.

STATUS OF THE RESEARCH

Draft final report nearly complete.

Planning and Administration

TECHNICAL ADVISORY COMMITTEE (TAC)

Project Champion: Steve Abney, MVD Enforcement
Project Sponsor: Stacey Stanton, MVD Director
MVD: Steve Abney, Ric Athey, Michael Veucasovic,
FHWA: Karen King
Structures: Jean Nehme
ATRC:

SPR-641, *Over-Dimensional Vehicle Routing Study*

Research Agency:	Arizona Transportation Research Center	FY Authorization:	2007
Principal Investigator(s):	Pending	Contract Date:	Pending
Contract Amount:	Pending	Sched. Completion Date:	12/31/08
Program Budget:	$15,000	Estimated Completion Date:	12/31/08
Expenditures to date:	0	On schedule?	Yes
Available Amount:	$15,000	ADVANTAGE No.	R062019P
Percent complete through 6/30/08	5%	Responsible ATRC Staff: (Project Manager)	Frank Darmiento

PROBLEM STATEMENT

Oversized and overweight vehicles present unique demands on the road system. Vehicle, weight, width, length, and/or height make it impossible to travel on some roads and difficult to travel on others. This increases the time and expense of transporting these large, indivisible loads and, in some cases, may prohibit access to the desired client user or critical infrastructure point. In order to ascertain whether there are feasible and cost-effective ways of reducing the time and expense incurred in transporting such items we must first identify the magnitude of the current problem.

The Arizona Department of Transportation (ADOT) needs to do a study examining the frequencies and routes taken for moving these over-dimensional and/or overweight loads as a first step toward determining practical steps for dealing with these shipments. If we can get a reasonable estimate of the cost of the current methods for accommodating these shipments we will have a better idea of whether different methods of accommodating these shipments ought to be explored.

RESEARCH OBJECTIVES

The initial objectives are to gather information that will help ADOT decide whether:

1. The problem is too small to justify further study or action.
2. The problem is significant enough to warrant an initial corridor pilot study to evaluate over-dimensional vehicle obstacles on a segment of a specific corridor and delivery delays and associated costs created – compared with potential correction costs for the corridor.

EXPECTED IMPLEMENTATION

It is expected that the study results will inform a decision on whether to proceed to an additional phase of study.

STATUS OF THE RESEARCH

The project is underway.

Planning and Administration

TECHNICAL ADVISORY COMMITTEE (TAC)

Project Champion: Richard Dungan, Trucking Industry
Project Sponsor: Jean Nehme, Bridge Group
Prescott District: John Fought
Phoenix Maintenance District: George Chin
Materials: Paul Burch
MVD: Steve Abney
FHWA: Ed Stillings
ATRC:

SPR-642, *Delivery of a Technical Curriculum Using Learner-Based Instruction and Communication Modalities in a Distributed Environment*

Research Agency:	Arizona Transportation Research Center	FY Authorization:	2007
Principal Investigator(s):	Larry Ellis	Contract Date:	NA
Contract Amount:	NA	Sched. Completion Date:	05/31/09
Program Budget:	$24,000	Estimated Completion Date:	05/31/09
Expenditures to date:	0	On schedule?	Yes
Available Amount:	$24,000	ADVANTAGE No.	R064219P
Percent complete through 6/30/08	25%	Responsible ATRC Staff: (Project Manager)	Frank Darmiento

PROBLEM STATEMENT

The complexity and volume of information a Motor Vehicle Division (MVD) Customer Services Representative must learn have increased geometrically because of new federal and state homeland security requirements, increasingly complex connectivity among the 49 states and foreign jurisdictions, and the movement of foreign state populations, organizations, products and services into and through Arizona. As in migration continues to exceed out migration, more MVD services will be required to serve the public throughout the state.

Pressure to keep wait times at a designated level, marginal funding to support the increased demand for services, and non-productive lost time traveling to and from a training site have impacted how training can be delivered without requiring additional resources and in the shortest amount of time possible.

Because of the increasing size of the population, the expanded scope of training, and the scarcity of resources, training must be made as effective as possible at a minimum cost in the shortest amount of time. Pure asynchronous delivery was tested several years ago and failed because of the changing profile of the students, the turnover of students and trainers, and the minimally effective results of technical instruction without direct instructor access. For the non–traditional form of training and learning to be effective, the students must have direct and timely access to an instructor and to multimedia learning modalities to ensure maximum understanding. This study will identify what technology should be used to blend a learning program for use in a distributed environment.

RESEARCH OBJECTIVE

1. The research should identify a blended training infrastructure that will integrate with ADOT's hardware, software, communications links, networks, and the existing Department Learning Content Management System (LCMS). The systems that will be evaluated should meet training and communication needs of all ADOT, not just MVD.

EXPECTED IMPLEMENTATION

The project will identify needs for desired training technology based infrastructure, develop and pilot-test an integrated virtual technology training and communications program.

Planning and Administration

STATUS OF THE RESEARCH

The project is underway.

TECHNICAL ADVISORY COMMITTEE (TAC)

Project Champion: John Carlson, MVD Assistant Director
Project Sponsor: Stacey Stanton, MVD Director
ITG: Omar Guillen, Cyndi Striegler,
MVD: Mary King; Larry Ellis, Karen Harmon,
ITD: Annie Parris, Diane Minton
FHWA: Ed Stillings
ATRC

SPR-646, AASHTOWare Turborelocation Software Development

Research Agency:	AASHTO	FY Authorization:	2008
Principal Investigator(s):	Tony Bianchi	Contract Date:	Pending
Contract Amount:	Pending	Sched. Completion Date:	12/31/09
Program Budget:	$100,000	Estimated Completion Date:	12/31/09
Expenditures to date:	0	On schedule?	Yes
Available Amount:	$100,000	ADVANTAGE No.	R064620P
Percent complete through 6/30/08	0%	Responsible ATRC Staff: (Project Manager)	Frank Darmiento

PROBLEM STATEMENT

Payment of relocation benefits is mandated by federal regulation and state law. A relocation software package would provide agencies with the ability to allocate scarce personnel and resources to carry out relocation calculation and documentation functions that meet both federal and state requirements in a consistent manner. FHWA supports this project. AASHTO will manage the pooled fund phase of the project with participation from multiple states to pay for the product design. ADOT-R/W IT support will conduct the phase 2 implementation.

RESEARCH OBJECTIVE

This project would be conducted in two phases. The first phase ($90,000) entails cooperation in a pooled fund effort to develop a web-based application that is easy to implement (i.e., has low in-house IT resource requirements) and has the ability to create reports both for state and federal reporting requirements. The second phase ($10,000) will entail implementing the results of phase 1 by customizing the model to ADOT's precise needs.

EXPECTED IMPLEMENTATION

States that participate in the project will own a copy of the finished product. Pooled fund product would be owned by AASHTO. R/W will own ADOT's customized version.

STATUS OF THE RESEARCH

This pooled fund project is not yet underway.

TECHNICAL ADVISORY COMMITTEE (TAC)

Project Champion: Sam Maroufkhani, Assistant State Engineer
Project Sponsor: Sabra Mousavi, Chief R/W Agent (ph. 6840)
Ben Black, ADOT-R/W IT support, Dianna Ayers, Washington DOT; Perry Johnston, Arkansas DOT; Rick Kauzlarich, Alaska DOT; Carmen Reese, Idaho DOT; Arnold Feldman, FHWA, Susan Lauffer, FHWA, Arnold Feldman, FHWA, John Semmens, ATRC, Tony Bianchi, AASHTO Project Manager (tbianchi@aashto.org, phone: (202)624-5821

SPR-654, *Options & Impacts of Measures to Reduce Single-Occupant Vehicle (SOV) Traffic*

Research Agency:	UrbanTrans Consultants	FY Authorization:	2008
Principal Investigator(s):	Bill Obermann	Contract Date:	3/11/08
Contract Amount:	$50,000	Sched. Completion Date:	12/31/08
Program Budget:	$50,000	Estimated Completion Date:	12/31/08
Expenditures to date:	$7,567	On schedule?	Yes
Available Amount:	$42,433	ADVANTAGE No.	R065420P
Percent complete through 6/30/08	20%	Responsible ATRC Staff: (Project Manager)	Dianne Kresich

PROBLEM STATEMENT

Arizona's population is growing and with all the opportunities this will bring to the State, one of the major concerns is transportation gridlock on local streets and state highways. Perhaps incentives like tax credits for reduced personal mileage, payment for not driving alone, increased effort on ability to work at home, grocery delivery to the home, personal services at the work site or disincentives like tolls, personal tax based on higher than average mileage in a year, charge for parking (work and social) could have a significant impact.

We need to consider more aggressive measures for reducing traffic congestion. The two largest cities Phoenix and Tucson already have Travel Reduction Ordinances in place targeted to employers to reduce employee drive alone trips to the work site. While these programs are making a contribution, something much stronger and dynamic may need to be implemented to increase the impact on traffic congestion.

RESEARCH OBJECTIVE

The objective would be to estimate the magnitude of impact and effectiveness of various plausible incentives and disincentives to reduce SOV travel. The research should identify the most promising options and recommend a pilot test protocol for ascertaining the effectiveness of one or more of these options in an Arizona location.

EXPECTED IMPLEMENTATION

It is expected that the study will result in a follow-up pilot test that will help guide future widespread measures to reduce SOV travel.

STATUS OF THE RESEARCH

The project is underway.

Planning and Administration

TECHNICAL ADVISORY COMMITTEE (TAC)

Project Champion: Cherie Campbell (PAG)
Project Sponsor: (MPD)
PAG: Rita Hildebrand
PTD: Matt Carpenter
Valley Metro RPTA: Betsy Turner,
State RideShare: Abby Williams or Kayelen Rolfe
FHWA: Karen King
ATRC: Dianne Kresich

SPR-655, *Identifying Customer-Focused Performance Measures*

Research Agency:	ETC	FY Authorization:	2008
Principal Investigator(s):	Christopher Tatham	Contract Date:	06/20/2008
Contract Amount:	$99,950	Sched. Completion Date:	12/31/08
Program Budget:	$100,000	Estimated Completion Date:	12/31/08
Expenditures to date:	0	On schedule?	Yes
Available Amount:	$100,000	ADVANTAGE No.	R065520P
Percent complete through 6/30/08	0%	Responsible ATRC Staff: (Project Manager)	Sally Stewart

PROBLEM STATEMENT

The goal of this research is to develop performance indicators from the perspective of residents, without reference to which section of the Arizona Department of Transportation (ADOT) performs the work. No research or involvement of residents has occurred to determine if performance measures currently used by ADOT are aligned with the measurements desired by residents. The research would incorporate input from residents to develop agency performance measures by addressing questions such as, "Where should ADOT be focusing its efforts?" and "What's important to residents?" This research would determine issues that residents regard as important performance indicators for the agency to be successful. The research would make recommendations for communicating performance measures to residents by creating a cycle of input given, indicators adopted, performance measured and results communicated.

RESEARCH OBJECTIVE

Evaluate procedures used elsewhere for measuring performance from the perspective of residents. Define a catalog of services to educate residents about ADOT responsibilities. Assess how Arizona residents perceive the indicators of our successful performance. Develop a user-friendly process to communicate with residents about the performance of ADOT.

EXPECTED IMPLEMENTATION

It is expected that the study will create performance measurements that can be repeatedly used in the fulfillment of the Department's strategic plan and set up a system for regularly communicating progress to residents and government decision makers.

STATUS OF THE RESEARCH

The project is underway.

TECHNICAL ADVISORY COMMITTEE (TAC)

Project Champion: Matt Burdick, CCP
Project Sponsor: John Bogert, Chief of Staff
CCP/ATRC: Sally Stewart
Director's Office: Dian Work
MPD: Brian Fellows
MVD: Holly Bowers
Strategic Planning: Robert Melore, Melissa Wynn

Planning and Administration

FHWA: Karen King
MVD: Jean Agan
FHWA: Jermaine Hannon

SPR-657, *Options for Reducing Copper Theft*

Research Agency:	ArrayNet	FY Authorization:	2008
Principal Investigator(s):	Jeremy Schoenfelder	Contract Date:	Pending
Contract Amount:	$13,750	Sched. Completion Date:	12/31/08
Program Budget:	$15,000	Estimated Completion Date:	12/31/08
Expenditures to date:	$5,893	On schedule?	Yes
Available Amount:	$9,107	ADVANTAGE No.	R065720P
Percent complete through 6/30/08	50%	Responsible ATRC Staff: (Project Manager)	Frank Darmiento

PROBLEM STATEMENT

The goal of this research is to develop performance indicators from the perspective of residents, without reference to which section of the Arizona Department of Transportation (ADOT) performs the work. No research or involvement of residents has occurred to determine if performance measures currently used by ADOT are aligned with the measurements desired by residents. The research would incorporate input from residents to develop agency performance measures by addressing questions such as, "Where should ADOT be focusing its efforts?" and "What's important to residents?" This research would determine issues that residents regard as important performance indicators for the agency to be successful. The research would make recommendations for communicating performance measures to residents by creating a cycle of input given, indicators adopted, performance measured and results communicated.

RESEARCH OBJECTIVE

Evaluate procedures used elsewhere for measuring performance from the perspective of residents. Define a catalog of services to educate residents about ADOT responsibilities. Assess how Arizona residents perceive the indicators of our successful performance. Develop a user-friendly process to communicate with residents about the performance of ADOT.

EXPECTED IMPLEMENTATION

It is expected that the study will create performance measurements that can be repeatedly used in the fulfillment of the Department's strategic plan and set up a system for regularly communicating progress to residents and government decision makers.

STATUS OF THE RESEARCH

The project is underway.

TECHNICAL ADVISORY COMMITTEE (TAC)

Project Champion: Lonnie Hendrix, Statewide Maintenance
Project Sponsor: Tim Wolfe, District Maintenance
TOC: Scott E. Nodes
Risk Mgmt: Cindy Eiserman
District Maintenance: Chuck McClatchey, David L Smith, Joe McGuirk
FHWA: Alan Hansen
ATRC:

Planning and Administration

SPR-660*, Arizona Transportation History*

Research Agency:	History Plus	FY Authorization:	2008
Principal Investigator(s):	Mark Pry	Contract Date:	06/20/2008
Contract Amount:	$25,000	Sched. Completion Date:	12/31/2008
Program Budget:	$25,000	Estimated Completion Date:	12/31/2009
Expenditures to date:	0	On schedule?	Yes
Available Amount:	$25,000	ADVANTAGE No.	R066020P
Percent complete through 6/30/08	0%	Responsible ATRC Staff: (Project Manager)	Frank Darmiento

PROBLEM STATEMENT

The Arizona Centennial will occur in 2012, and will mark Arizona's one hundred years of statehood. As stated on Centennial Web site, "Arizona commemorates 100 years of Statehood on February 14, 2012. As the last of the contiguous 48 states admitted to the Union, Arizona and its citizens have a wonderful opportunity to showcase the state's beauty, history and future." The history of transportation in the state is integral to its overall growth and development. It is proposed that text be developed to document the development of the state's transportation network – and ADOT's role – from prehistoric times to the present.

The Arizona Centennial project draws attention to a unique opportunity to collect and share valuable information on transportation history with the media, students in Arizona schools, potential tourists, and the public. The text developed by this research project would provide ADOT with the basis for producing a variety of products highlighting the development of the state's multimodal transportation system. These products will be valuable and timely. The products could include a booklet, map, poster, etc., and would be distributed by ADOT at various outreach events related to the Centennial, as well as "ribbon-cutting" ceremonies for highway projects, public meetings for ADOT studies, etc. They could also be made available to Arizona schools to educate students on the role of transportation in the development of the state.

RESEARCH OBJECTIVE

The objectives are:

1. Develop a comprehensive overview of the history of transportation in Arizona, from prehistoric to the present.
2. Educate residents, visitors, and students about the history of transportation in Arizona and the role of ADOT in the growth and development of Arizona's population and economy.

EXPECTED IMPLEMENTATION

This project is expected to generate attractive products that ADOT can use to increase awareness of the agency's role in aiding the growth and prosperity of the state.

STATUS OF THE RESEARCH

The project has just been awarded.

Planning and Administration

TECHNICAL ADVISORY COMMITTEE (TAC)

Project Champion: Dianne Kresich, MPD
Project Sponsor: Tim Tait, CCP
CCP: Dan Dudzik
ITD: to be named later
FHWA: Karen King
ATRC: Dale Steele

SPR-662, *Cost Effectiveness of MVD Fee Collections*

Research Agency:	Arrowhead Solutions	FY Authorization:	2008
Principal Investigator(s):	Chris Ciofi	Contract Date:	Pending
Contract Amount:	$25,000	Sched. Completion Date:	12/31/2008
Program Budget:	$25,000	Estimated Completion Date:	12/31/2009
Expenditures to date:	0	On schedule?	Yes
Available Amount:	$25,000	ADVANTAGE No.	R066220P
Percent complete through 6/30/08	0%	Responsible ATRC Staff: (Project Manager)	Frank Darmiento

PROBLEM STATEMENT

Currently, MVD collects fees for over 300 different types of fees. Many of these fees have remained unchanged for decades and may not reflect the actual cost of processing the transactions or may not generate enough revenue to cover the cost of collecting the fee. Based on this, the Arizona Auditor General recommended that MVD undertake a study of the cost effectiveness of these fees to determine which ones should, at a minimum, be increased to meet transaction cost and those that are no longer cost effective to collect or are no longer needed.

RESEARCH OBJECTIVE

The purpose of this study is to identify the total cost of each fee selected and compare the cost to the revenue generated from the fee. If we can quantify the benefits and costs for each selected fee, we can establish an optimal level of effort and recommend to the state legislature appropriate fee changes or discontinuance of fees that are not cost effective or no longer needed.

EXPECTED IMPLEMENTATION

It is expected that the study results will help guide MVD and ADOT to implement a more cost effective fee collection program. This includes recommendations for fees that should be increased to meet the estimated cost of the transaction and those that are not cost effective or that are no longer needed.

STATUS OF THE RESEARCH

The project has just been awarded.

TECHNICAL ADVISORY COMMITTEE (TAC)

Project Champion: George Delgado (MVD)
Project Sponsor: Stacey Stanton, MVD
Craig Reed (MVD)
Jean Agan (MVD Customer Service Program)
Brad Steen (ADOT Chief Economist)
Sheryl Bodmer (ADOT Accounting Office).
FHWA: Karen King
ATRC:

SPR-676, *Assessing How "New Media" Can Bolster ADOT's Outreach and Communication Effectiveness*

Research Agency:	Pending	FY Authorization:	2009
Principal Investigator(s):	Pending	Contract Date:	Pending
Contract Amount:	Pending	Sched. Completion Date:	12/31/2009
Program Budget:	$125,000	Estimated Completion Date:	12/31/2009
Expenditures to date:	0	On schedule?	Yes
Available Amount:	$125,000	ADVANTAGE No.	R067621P
Percent complete through 6/30/08	0%	Responsible ATRC Staff: (Project Manager)	Frank Darmiento

PROBLEM STATEMENT

The Arizona Department of Transportation (ADOT) has a compelling interest in examining how recent technological advancements might support improved outreach and communication activities with the diverse residents of the state. As the Web has evolved, users are seeking richer, more personalized experiences. Emerging tools on the Web may allow the Department to better connect with customers. This research would explore opportunities that could be integrated into ADOT's existing Web site platform to form a foundation for which the Department can implement strategically aligned outreach efforts. This research will help ADOT allocate resources, manage costs, and improve public trust in the agency's statewide progress and efforts. This research will serve as the foundation for an implementation plan to make better use of New Media resources.

RESEARCH OBJECTIVES

(1) Evaluate the range of feasible Web 2.0/New Media technologies available and applicable to ADOT. (2) Define stakeholder knowledge of these tools, previous experience using them and interest in receiving ADOT information from a means identified as New Media. (3) Assess the type of information Arizona residents are interested in receiving via New Media techniques and the approach the agency should take in approaching these new tools. (4) Develop and launch one research-based New Media outreach tool and assess the effectiveness from a baseline status through programmatic integration.

EXPECTED IMPLEMENTATION

It is expected this research will identify New Media communication strategies that can be repeatedly used in the fulfillment of the department's strategic plan and embedded into existing outreach programs to demonstrate agency innovation and excellence.

STATUS OF THE RESEARCH

The project has not yet been awarded.

TECHNICAL ADVISORY COMMITTEE (TAC)

Project Champion: Timothy Tait, CCP
Project Sponsor: Matt Burdick, CCP

Planning and Administration

Proposed Technical Advisory Committee: CCP – 1, MVD – 1, ITD – 2, MPD – 2, AERO – 1, TSG – 1, (Arizona Transportation Research Center--ATRC).

SPR-683, *Feasibility Test of CAD Web Menus*

Research Agency:	Pending	FY Authorization:	2009
Principal Investigator(s):	Pending	Contract Date:	Pending
Contract Amount:	Pending	Sched. Completion Date:	12/31/2009
Program Budget:	$75,000	Estimated Completion Date:	12/31/2009
Expenditures to date:	0	On schedule?	Yes
Available Amount:	$75,000	ADVANTAGE No.	R068321P
Percent complete through 6/30/08	0%	Responsible ATRC Staff: (Project Manager)	Daryl Odom

PROBLEM STATEMENT

Computer Aided Design (CAD) standards menus are user tools for assisting in the preparation of plans. Each user group in the Arizona Department of Transportation (ADOT) utilizes its own standards menus adopted for their type of plan sheets. These standards menus are made available through numerous servers, local personal computers (PCs) and laptops. The ability to keep all of the various servers, PCs, and laptops up to date with current menus is a very difficult task due to their multiple locations and need to update each unit when a menu is updated. Therefore, some users may not be up to date with current menus until all units affected are individually updated. It is desired to explore the possibility of making standard menus available through the web so that they can be accessed through a common site by all users.

RESEARCH OBJECTIVES

The basic research objective is to pilot-test the feasibility of using web-based menus for agency-wide applications. The research tasks will include (1) selecting a pilot-test site & application, (2) writing/adapting a program aimed at achieving the objective, (3) testing this program for an appropriate period to ascertain its cost-effectiveness for possible agency-wide uses, (4) documenting the results in a written report.

EXPECTED IMPLEMENTATION

It is expected that the study will examine the feasibility, costs & benefits of adopting this technology throughout the agency.

STATUS OF THE RESEARCH

The project has not yet been awarded.

TECHNICAL ADVISORY COMMITTEE (TAC)

Project Champion: Daryl Odom, CAD Services
Project Sponsor: Mary Viparina, Roadway Design
Proposed Technical Advisory Committee: Suzan Tasvibi-Tanha (Information Technology Group--ITG), Fred Daniels (CAD Services), (Arizona Transportation Research Center--ATRC).

Structures – PROJECTS

SPR-493, *Bridge Foundation Design Parameters and Procedures for Bearing in SGC Soil*

Research Agency:	Arizona State University	FY Authorization:	2000
Principal Investigator(s):	Dr. Bill Houston	Contract Date:	11/18/00
Contract Amount:	$214,808	Sched. Completion Date:	05/17/02
Program Budget:	$214,808	Est. Completion Date:	11/30/04
Expenditures to date:	$180,596	Is project on schedule?	No
Available Amount:	$34,212	ADVANTAGE No.	R0493 12P
Percent complete Through 6/30/08	90%	Responsible ATRC Staff: (Project Manager)	Christ Dimitroplos

PROBLEM STATEMENT

Drilled shaft foundations support a significant portion of the bridge substructures in Arizona. These drilled shafts are commonly supported in mixed soils types known as sand-gravel-cobbles (SGC) layer and derive their capacities from side friction and end bearing in SGC layer. Current design procedures and parameters are based on uniform soil conditions. Soils medium is modeled either as clay or sand. Limited amounts of research data are available for design of drilled shafts supported in granular soils with significant gravel and cobble contents. Current American Association of State Highway and Transportation Officials (AASHTO) design method for drilled shafts in granular soils medium is based on the equations proposed by Reese and O'Neil (Federal Highway Administration (FHWA) Procedure). Meyerhoff and Kulhawy developed the other two common design procedures. Available load test data indicate that measured drilled shaft capacities tend to be larger with an increase in gravel content of the granular soils than the design capacities. Additionally, the capacity tends to increase with the increase of calcium carbonate cementation. However, definitive relationships among these variables and corresponding design parameters are not available for general design applications. Drilled shafts in mixed soils (i.e., SGC) conditions will support significant number of bridge foundations in the future. Significant savings could be realized if design parameters and procedures could be developed to account for the increase in friction of soils with the increase of gravel content and calcium carbonate cementation.

RESEARCH OBJECTIVES

1. Prepare an evaluation of the current AASHTO design methods for Drilled Shaft foundation.
2. Prepare a comparative analysis of Drilled Shaft foundations based on AASHTO design method and those based on load tests in granular soils with gravel and cobbles.
3. Evaluate the added strength of soils due to the presence of gravel and cobbles along with/without cementation in soils.
4. Recommend changes in design parameters and design procedures.

The following tasks will be performed:

1. Develop a Technical Advisory Committee (TAC).
2. Meet with TAC to prepare a Scope of Work and select a consultant.
3. Conduct a literature search on the issues of drilled shaft foundation design in granular soils.
4. Conduct an evaluation of the current AASHTO design methods for drilled shaft foundation, for their basis and limitations in regard to SGC materials.
5. Prepare a comparative study of drilled shaft capacities based on AASHTO design methods and those based on load test data in granular soils with gravel and cobbles.
6. Identify the design parameters that could be modified to account for additional capacities of drilled shaft foundation in SGC soils with and without cementation.
7. Develop design parameters and procedures for drilled shafts supported by SGC soils.
8. Prepare a memo for submittal to AASHTO Technical Committee T-15 for revision of the AASHTO procedure for design of drilled shaft foundations.
9. Document the research efforts and findings in a final report.

EXPECTED IMPLEMENTATION

The research has resulted in an evaluation of the current AASHTO design method for drilled shaft foundations based on the available load test data on drilled shafts in SGC soils. The research has provided information to be used to improve the design of drilled shaft foundations for bridges and structures.

STATUS OF THE RESEARCH

The research has been basically completed during the past year. Research work was on hold while a separate effort to initiate a related Federal Pooled Fund project was monitored. The completed final draft report has been submitted to ATRC for review before publication.

TECHNICAL ADVISORY COMMITTEE (TAC)

Dan Heller	TY Lin, Inc.
Shafi Hasan	Bridge Engineering, ADOT
J.J. Liu	Materials, ADOT
Doug Alexander	Materials, ADOT
Aryan Lirange	FHWA
Christ Dimitroplos	ATRC, ADOT

SPR-538, *High Performance Concrete for Bridge Structures in Arizona*

Research Agency:	Jabar Engineering	FY Authorization:	2002
Principal Investigator(s):	Tarif Jabar, P.E.	Contract Date:	August 2003
Contract Amount:	$275,000	Sched. Completion Date:	May 2005
Program Budget:	$275,000	Est. Completion Date:	Sept 2006
Expenditures to date:	$260,200	Is project on schedule?	Yes
Available Amount:	$14,800	ADVANTAGE No.	R053814P
Percent complete Through 6/30/08	95%	Responsible ATRC Staff: (Project Manager)	Christ Dimitroplos

PROBLEM STATEMENT

In order to stimulate the use of higher quality concrete in highway structures, the Federal Highway Administration has strongly promoted high performance concrete (HPC) materials. High performance concrete has been found to be feasible in all aspects of concrete bridges including the decks, piers, and pre-stressed concrete girder cross-sections. Several studies have indicated that using concrete compressive strengths of up to 10,000 psi allowed longer span lengths and more economical structures. Many state agencies have thus saved construction time and money by using high performance concrete. One of the reasons why HPC is not regularly specified for highway structures in Arizona may be the lack of available data regarding the field use in hot and arid climates. This proposal will seek to develop and implement the use of high performance concrete in Arizona's bridges.

RESEARCH OBJECTIVES

The objectives of this research project are to evaluate the applicability of using high performance concrete in structures in Arizona and to determine any climate-related issues associated with the use of high performance concrete.

Action Plan - Tasks

The researcher will accomplish the following tasks:

1. Meet with the Technical Advisory Committee to discuss the scope of work and action plan.
2. Conduct a literature and research-in-progress search and review the practice within Arizona, other departments of transportation, and throughout the industry. Prepare a state-of-the-art/state-of the practice report.
3. In addition to improved durability effects, the effect of using HPC in the deck will be evaluated on the flexural strength, ductility, pre-stress losses, and long-term deflections of the superstructure
4. Several mix designs will be developed and used in a laboratory-testing program. Performance based tests will be conducted to assess the characteristics of the materials.
5. Prepare a plan and specifications for the design and construction of a designated high performance concrete bridge project in Arizona. The plan shall include high performance concrete mixtures for the Arizona Department of Transportation Bridge Group to use for the

design of bridge columns, girders, and decks. The plan will also address the curing requirements, shrinkage cracking, strength, and toughness requirement.

6. Results will be documented and compiled as a user-manual for high performance concrete in bridge structures in hot and arid climates. A cost analysis study will be performed. Results will be used to identify possible modifications to current practice.
7. Document the research effort and findings in a final report in accordance with ATRC guidelines.

EXPECTED IMPLEMENTATION

This project will increase the acceptability of high performance concrete materials in the local community. It will help address some of the process, parameters, and design challenges faced by the bridge group in designing cost-effective, compact, and strong structures through the use of higher strength materials. By reducing extra piers and members, it may reduce the size requirements of many new and rehabilitated structures**.** The research results were tested on Sunshine Bridge in Holbrook. A draft report is being completed.

STATUS OF THE RESEARCH

Consultant contract awarded and research project underway. Literature research completed.

TECHNICAL ADVISORY COMMITTEE (TAC)

Aryan Lirange	Federal Highway Administration
Jean Nehme	Bridge Group
Oscar Mousavi	Materials
Henry M. Sung	Bridge Design
Greg Lingor	Parsons Group
Shawn Farahzadi	Construction
	Construction Inspection
	District Engineer

SPR-586, *Earth Pressures on Cantilevered Retaining Wall*

Research Agency:	Pending	FY Authorization:	2005
Principal Investigator(s):	Pending	Contract Date:	Pending
Contract Amount:	Pending	Sched. Completion Date:	October 2005
Program Budget:	$150,000	Est. Completion Date:	October 20005
Expenditures to date:	$0	Is project on schedule?	No
Available Funds	$150,000	ADVANTAGE No.	R0586 17P
Percent complete Through 6/30/08	0%	Responsible ATRC Staff: (Project Manager)	Christ Dimitroplos

PROBLEM STATEMENT

A number of significant research projects related to backfill material for retaining structures have been performed over the last decade. Cohesive soil, controlled low strength materials (CLSMs), recycled tire chip soil mix and more were studied for backfill material. Neither recycled asphaltic pavement (RAP) nor recycled crushed concrete backfill mix have been included in these studies. Recently contractors on several ADOT construction projects proposed using recycled concrete materials for structure backfill behind concrete cantilever retaining walls. Contractors have claimed that recycling existing concrete material from pavement removal in the vicinity of the project and using the material for the structure backfill behind the new retaining wall construction would be a significant cost saving idea.

ADOT Geotechnical Design Section of Materials Group and Bridge Design Sections of Bridge Group are very Group are hesitant to adopt the application of the proposed backfill material because of unavailability of data for design parameters for these materials unless extensive research is performed in this area. These design parameters consist of unit weight, internal frictional angle, shear strength, permeability, compaction, moisture content etc. The amount of moisture retained in the backfill material is directly related to the permeability of backfill and will greatly affect the earth pressure acting on the wall. The gradation of the mix will also affect performance properties of the backfill material. The findings of this investigation will provide ADOT the necessary information for evaluating the proposed materials objectively. Future use of these materials is heavily dependent on the results of this research.

RESEARCH OBJECTIVES

Investigate the performance of concrete cantilever retaining walls having (1) Structure Backfill meeting ADOT's current specifications (2) Structural Backfill consisting of a mixture of recycled asphaltic concrete and virgin aggregate material (3) Structural Backfill consisting of a mixture of recycled Portland Cement Concrete and virgin aggregate material.

1. Identify appropriate blend percentages for mixtures containing recycled and virgin aggregate materials.
2. Identify quality and gradation requirements for the above backfill materials
3. Establish backfill drainage and compaction criteria.
4. Investigate earth pressure and pore water pressure on wall face.
5. Examine the effect on backfill settlement, including long-term effects if any.

RESEARCH TASKS

1. Develop a Technical Advisory Committee (TAC).
2. Meet with TAC to prepare a scope of work and select a consultant.
3. Conduct a brief literature search on the topic of structural backfill for retaining walls, including the use of recycled materials.
4. Select and establish sample mixes for each of the types of backfill materials mentioned in Research Objectives.
5. Conduct necessary soil tests in order to obtain design parameters for the selected backfill sample mixes so that unit weight, internal frictional angle, shears strength, etc. can be determined. Evaluate the affect of time and temperature on the engineering properties and performance of Structural Backfill materials containing RAP.
6. Provide performance curves for the relevant design parameters as a function of blend percentage to justify an allowable maximum amount of recycled material in structural backfill.
7. Document the research effort and findings in a final report. The report should enable ADOT to evaluate the benefit of using recycled concrete materials versus conventional backfill materials.
8. Develop specifications, placement procedures/conditions, and evaluate testing requirements/feasibility for controlling the use of these materials.
9. If the finding indicates that using recycled concrete backfill materials for concrete cantilever retaining wall has the advantage in cost and quality over the conventional structural backfill material, ADOT Bridge Group will evaluate whether redesigning of the ADOT standard retaining wall is warranted.

EXPECTED IMPLEMENTAION

This research will provide the technical information to ADOT with which to accurately evaluate the quality and value of using a variety of concrete backfill mixes that are proposed by contractors.

STATUS OF RESEARCH

This research has not yet begun.

TECHNICAL ADVISORY COMMITTEE

(Proposed) Scott Weinland, Regional Materials; Henry Sung, Bridge Group; John Ivanov, Materials Group; Christ Dimitroplos, ATRC; James Wilson, Materials Group

Traffic and Safety – PROJECTS

SPR-625, *Safety Enhancements for Median Crossovers*

Research Agency:	Pending	FY Authorization:	2007
Principal Investigator(s):	Pending	Contract Date:	NA
Contract Amount:	Pending	Sched. Completion Date:	NA
Program Budget:	$30,000	Est. Completion Date:	NA
Expenditures to date:	0	On schedule?	NA
Available Amount:	$30,000	ADVANTAGE No.	R062519P
Percent complete Through 6/30/08	0%	Responsible ATRC Staff: (Project Manager)	Jason Harris

PROBLEM STATEMENT

ADOT workers and DPS officers face serious safety issues when work requires them to turn around on limited access highways. Rural corridors have few interchanges, so emergency use of designated safe crossovers is necessary. Many other flat median areas can be unsafe, due to soft soils or poor sight lines. ADOT has standards for marking approved crossovers for official vehicles, but which may be obscured in poor visibility conditions (fog, rain, snow, dust, smoke). Patrol officers, snowplow operators, fire crews or tow truck drivers who must slow down in the high-speed left lane to look for, or to turn into, the median crossover are all at great risk, as are the other highway users. A more reliable approach is needed to mark crossovers and to provide sufficient lead time to signal and safely slow down.

RESEARCH OBJECTIVES

This project will perform a state-of-the practice review of the most current on-board and on-site concepts to accurately locate approved crossovers in advance of the decision point. It would include a national Internet and literature search of current products and practices using winter maintenance industry and agency resources. Focus groups including other agencies and private parties would inform stakeholders on the safety issues and confirm their needs. The most practical, economical solutions for ADOT would be identified from current best practices and non-technical innovations 'on the ground' by others.

EXPECTED IMPLEMENTATION

Recommendations would be made for both technical and non-technical alternative solutions that are practical, low-cost, and effective for each of the primary regional visibility issues.

STATUS OF THE RESEARCH

The project is not yet underway.

TECHNICAL ADVISORY COMMITTEE (TAC)

Lonnie Hendrix	Central Maintenance, Champion/Sponsor
Districts	Statewide
Karen King	FHWA

SPR-648, *Crash Related Education, Enforcement, and Engineering Factors*

Research Agency:	Pending	FY Authorization:	2008
Principal Investigator(s):	Pending	Contract Date:	NA
Contract Amount:	Pending	Sched. Completion Date:	NA
Program Budget:	$120,000	Est. Completion Date:	NA
Expenditures to date:	0	On schedule?	NA
Available Amount:	$120,000	ADVANTAGE No.	R064820P
Percent complete Through 6/30/08	0%	Responsible ATRC Staff: (Project Manager)	Jason Harris

PROBLEM STATEMENT

Crashes are the result of the coincidental occurrence of a combination of factors that exceed the drivers capability to maintain vehicle control. Identifying these contributing factors as education, enforcement, and engineering related would facilitate targeted remedial action.

In a typical lane departure crash an impaired driver exceeds a safe speed, the vehicle leaves the paved surface, the driver reacts by overcorrecting in an attempt to return to the paved surface, the vehicle overturns, occupants not restrained are ejected and perish. Targeting these factors with a combination of education, enforcement, and engineering efforts will provide engineers, law enforcement, and educators a better understanding of what is contributing to crashes and how to address them.

RESEARCH OBJECTIVES

Review fatal and serious injury crash reports to identify and categorize contributing factors such as overturn, type of vehicle, etc. and place in baskets similar to the Accident Location Identification Surveillance System (ALISS) database. Analyze and determine appropriate, effective education, enforcement, and engineering mitigation measures.

EXPECTED IMPLEMENTATION

Results that identify contributing factors and the associated effective enforcement, education, and engineering measures will be forwarded to the responsible agencies for incorporation into their ongoing programs.

STATUS OF THE RESEARCH

The project is not yet underway.

TECHNICAL ADVISORY COMMITTEE (TAC)

Reed Henry	Traffic HES, Champion/Sponsor
TBD	Communication & Community Partnerships
Jeff King	DPS
Michael Hegarty	Governor’s Office of Highway Safety
TBD	Department of Health Services
Jennifer Brown	FHWA

SPR-651, *Incorporating safety performance into project design decision-making for cost effective safety enhancements*

Research Agency:	Pending	FY Authorization:	2008
Principal Investigator(s):	Pending	Contract Date:	NA
Contract Amount:	Pending	Sched. Completion Date:	NA
Program Budget:	$50,000	Est. Completion Date:	NA
Expenditures to date:	0	On schedule?	NA
Available Amount:	$50,000	ADVANTAGE No.	R065120P
Percent complete Through 6/30/08	0%	Responsible ATRC Staff: (Project Manager)	Jason Harris

PROBLEM STATEMENT

Rigid conformity to existing policies, standards and guidelines, does not guarantee safety for the traveling public utilizing the state highway system. ADOT standards for a highway posted at 65 mph indicate a clear zone distance of 30 feet from the edge of the travel lane on level terrain with 6:1 side slopes. Typically the right of way line may be found 30 feet or more past the clear zone boundary. Within the area found between the clear zone boundary and the right of way line, a myriad of hazardous fixed objects (trees, rocks, poles, electrical boxes, etc.) are frequently struck by errant vehicles that run off the pavement edge. Preliminary Traffic HES study results indicate that a majority of Run-Off-Road accidents occur at a distance of well over 30 feet from the pavement edge. As a result, it appears that wider clear zones need to be accommodated into the expansion of the clear zone distances that ADOT uses. In addition, there may be other standards, guidelines and “rules-of-thumb” that ADOT currently uses, which need some additional evaluation as well.

RESEARCH OBJECTIVES

Research each of the existing policies, standards, and guidelines that ADOT currently uses during project development to determine whether any low-cost safety enhancements could be incorporated into any existing standards, guidelines, procedures, or policies.

EXPECTED IMPLEMENTATION

Traffic Engineering working in conjunction with other ADOT organizations will lead the search for information, results, and implementation. Follow-up research is always plausible.

STATUS OF THE RESEARCH

The project is not yet underway.

Traffic and Safety

TECHNICAL ADVISORY COMMITTEE (TAC)

Reed Henry	Traffic HES, Champion
Mary Viparina	Roadway Engineering Group, Sponsor
Terry Otterness	Roadway Engineering Group
Jacob de Raadt	Roadway Engineering Group
Mike Marietti	Traffic Engineering
Tim Wolf	Phoenix Maintenance District
Cindy Eiserman	Risk Management
Jim Redpath	Attorney Generals Office
Karen King	FHWA
Jennifer Brown	FHWA
Jermaine Hannon	FHWA

SPR-652, *Countermeasures to Reduce Large Truck Crashes*

Research Agency:	Arizona State University	FY Authorization:	2008
Principal Investigator(s):	Soyoung Ahn	Contract Date:	2008
Contract Amount:	$100,000	Sched. Completion Date:	NA
Program Budget:	$100,000	Est. Completion Date:	NA
Expenditures to date:	0	On schedule?	NA
Available Amount:	$100,000	ADVANTAGE No.	R065220P
Percent complete Through 6/30/08	0%	Responsible ATRC Staff: (Project Manager)	Jason Harris

PROBLEM STATEMENT

ADOT's Motor Vehicle Division reported that trucks (large and small) constitute 27% of vehicles involved in crashes and 30% of fatal crashes. Although big-rig crashes are less frequent than those involving passenger cars, their impact on fatality and traffic congestion are far greater than passenger car related crashes. Hence, countermeasures to reduce big-rig crashes are crucial from the safety and congestion management standpoint.

RESEARCH OBJECTIVES

The objectives of this research are to identify freeway segments in Arizona with high frequencies of big-rig crashes and to develop countermeasures to reduce the probability of incident occurrence.

EXPECTED IMPLEMENTATION

Findings and recommendations from this study are expected to be deployed on the identified hot spots.

STATUS OF THE RESEARCH

The project is not yet underway.

TECHNICAL ADVISORY COMMITTEE (TAC)

Reed Henry	Traffic HES, Champion
TBD	MVD Enforcement, Sponsor
Kohinoor Kar	Traffic HES
Scott Nodes	Technology Group
Cindy Eiserman	Risk Management
Sarath Joshua	MAG
Karen King	FHWA
TBD	Governor's Office of Highway Safety
TBD	Federal Motor Carrier Safety Administration

SPR-663, *Development of Intersection Performance Measures for Timing Plan Maintenance Using an Actuated Controller – Phase I*

Research Agency:	Pending	FY Authorization:	2008
Principal Investigator(s):	Pending	Contract Date:	NA
Contract Amount:	Pending	Sched. Completion Date:	NA
Program Budget:	$25,000	Est. Completion Date:	NA
Expenditures to date:	0	On schedule?	NA
Available Amount:	$25,000	ADVANTAGE No.	R066320P
Percent complete Through 6/30/08	0%	Responsible ATRC Staff: (Project Manager)	Jason Harris

PROBLEM STATEMENT

Currently no automated methods for signalized intersection data collection are in place. This study is the first step in providing important operational information to Regional Traffic Engineers (RTEs), as well as long term turning movement information to planning and maintenance.

RESEARCH OBJECTIVES

This project is a pilot study to investigate the feasibility of using this technology on an Arizona Department of Transportation (ADOT) facility. The tasks required are:

1. Modify an existing cabinet to provide vehicle flow rate information from installed video detection.
2. Implement ASC/3 controller with data logging software at test location.
3. Develop a semi-automated method of retrieving data from test location.
4. Produce MOEs from collected data and verify with manual counts
5. Determine the approximate additional cost to equip a new intersection (or rehab) with equipment for MOE collection.

EXPECTED IMPLEMENTATION

Study results will inform a decision on whether to implement additional measures aimed at improving traffic congestion.

STATUS OF THE RESEARCH

The project is not yet underway.

TECHNICAL ADVISORY COMMITTEE (TAC)

John Harper, Flagstaff District Engineer
Walter 'Kent' Link, Regional Traffic Engineer
Chuck Gillick, Flagstaff Maintenance Engineer
Mike Manthey, Traffic Group
Mike Lessard, Traffic Group
Karen King, Federal Highway Administration
Scott Nodes, Transportation Technology Group

SPR-670, *Restraint Use (Seat belt and child passenger seats) Survey*

Research Agency:	Pending	FY Authorization:	2008
Principal Investigator(s):	Pending	Contract Date:	NA
Contract Amount:	Pending	Sched. Completion Date:	NA
Program Budget:	$25,000	Est. Completion Date:	NA
Expenditures to date:	0	On schedule?	NA
Available Amount:	$25,000	ADVANTAGE No.	R066320P
Percent complete Through 6/30/08	0%	Responsible ATRC Staff: (Project Manager)	Jason Harris

PROBLEM STATEMENT

In Arizona, lack of restraint usage (seatbelts and child passenger seats) was a contributing factor to an average of 687 fatalities per year which is nearly 60% of total fatalities. These tragic statistics could be dramatically decreased if effective strategies and educational messages will encourage more people to buckle up. Due to the great opportunity to safe lives, increasing restraint usage has been identified as one of five key emphasis areas of Arizona's Strategic Highway Safety Plan (available at www.gtsac.org) among impaired driving, young drivers, speed and roadway/roadside.

RESEARCH OBJECTIVES

1. Conduct survey to identify why (or why not) people use seatbelts in Arizona. The survey will be provided in English and Spanish to determine if differences exist between different cultures.
2. Analyze survey results.
3. Develop criteria and provide recommendations on the most effective means to get drivers to buckle up.
4. Present results at GTSAC (Governor's Traffic Safety Advisory Council) Restraint Use team meeting.

EXPECTED IMPLEMENTATION

Recommendations from the study will be forwarded to the Governor's Traffic Safety Advisory Committee. Cost of implementation will depend on the recommendations and agencies involved.

STATUS OF THE RESEARCH

The project is not yet underway.

TECHNICAL ADVISORY COMMITTEE (TAC)

Tomi St. Mars, Department of Health Services
Matt Burdick, Communications & Community Partnerships
Patricia Powers-Zermano, CCP
Karen King, FHWA
Michael Hegerty, GOHS
Linda Gorman, AAA Arizona
Larry Talley, MPD
Mike Manthey, Traffic Group

SPR-671, *Data Analysis Methodology to Identify Effective Countermeasures for Reducing Fatalities and Injuries on Arizona Roadways*

Research Agency:	Pending	FY Authorization:	2009
Principal Investigator(s):	Pending	Contract Date:	NA
Contract Amount:	Pending	Sched. Completion Date:	NA
Program Budget:	$100,000	Est. Completion Date:	NA
Expenditures to date:	0	On schedule?	NA
Available Amount:	$100,000	ADVANTAGE No.	R067121P
Percent complete Through 6/30/08	0%	Responsible ATRC Staff: (Project Manager)	Jason Harris

PROBLEM STATEMENT

In Arizona, traffic crash data is available for jurisdictions statewide; however, correlated with exposure data, such as, traffic volume data, for all segments and intersections within the State is very difficult. Therefore, some of the scientific methods of identifying candidate locations/areas/methods cannot be utilized until the data needs are met. The problem is to analytically identify specific safety issues at various locations/areas within the State using best available data resources. This research will enable each of the five technical emphasis area teams and the communications subcommittee of the Arizona Strategic Highway Safety Plan (SHSP) in developing candidate locations/areas and to identify most effective implementation projects or programs to address the issues. The technical emphasis areas are as follows: (1) Restraint Usage, (2) Speeding, (3) Young Drivers, (4) Impaired Driving, and (5) Roadway/Roadside.

RESEARCH OBJECTIVES

The objective is to develop a data analysis methodology that will track progress and target efforts in the SHSP emphasis areas and communication outreach where they will be most effective. The process and results developed through the research will be used in developing projects and programs that will have an impact in reducing fatalities and serious injuries on all public roads. The outcomes of this research should be readily useful to all SHSP emphasis area teams. See supplement information for specific tasks to be completed.

EXPECTED IMPLEMENTATION

The research results will be utilized in the SHSP implementation.

STATUS OF THE RESEARCH

The project is not yet underway.

TECHNICAL ADVISORY COMMITTEE (TAC)

Champions for each of the SHSP Emphasis Areas:

Tomi St. Mars – Department of Health Services: Champion for Restraint Usage; Linda Gorman – AAA Arizona: Champion for Young Drivers; Michael Hegarty – GOHS: Champion for Impaired Driving; Jeff King – DPS: Champion for Speed; Larry Talley – ADOT: TRCC Coordinator; Reed Henry – ADOT Safety Engineer: Champion for Roadway/Roadside; Matt

Traffic and Safety

Burdick – ADOT Communications & Community Partnerships Director: Champion for Communications; Cindy Eiserman - ADOT Risk Management; Esther Corbett – InterTribal Council of Arizona; Karen King, Jennifer Brown - FHWA

SPR-675, *Effectiveness of Young Driver Training and Graduated Licensing Laws*

Research Agency:	Pending	FY Authorization:	2009
Principal Investigator(s):	Pending	Contract Date:	NA
Contract Amount:	Pending	Sched. Completion Date:	NA
Program Budget:	$80,000	Est. Completion Date:	NA
Expenditures to date:	0	On schedule?	NA
Available Amount:	$80,000	ADVANTAGE No.	R067521P
Percent complete Through 6/30/08	0%	Responsible ATRC Staff: (Project Manager)	Jason Harris

PROBLEM STATEMENT

Licensed drivers in Arizona between the ages of 16 to 19 account for only 4.22% of the total drivers in 2006. Yet, drivers under the age of 20 account for approximately 11% of all motor vehicle crashes. According to the Arizona Department of Transportation (ADOT) Motor Vehicle Crash Facts Report for 2006, the number of drivers, who are of age less than 20, killed due to car crashes is 57 and injured 4,858, which are 10% and 11.6% of the total fatality and injury, respectively. These statistics indicate there is a significantly higher collision rate of young drivers compared to other age groups. Speeding and loss of control are the two major causes of vehicle crashes for this age group. Furthermore, an Allstate Foundation survey shows that among 16-year-old drivers, the leading cause of fatal crashes is driver error (77%). The current Arizona law does not require young drivers to take any formal training class before the first driver license exam. Many high schools are eliminating driver education from their curriculum due to budget constraints and other priorities.

RESEARCH OBJECTIVES

To evaluate the current practice of young driver training programs, including available public service announcements, and to develop effective training curriculum and safe driving campaigns to improve young driver skills and attitude towards driving.

EXPECTED IMPLEMENTATION

The research results will be provided to ADOT's Motor Vehicle Division and the state legislature for their consideration of adopting new young driver training methods and potentially enhanced GDL laws.

STATUS OF THE RESEARCH

The project is not yet underway.

TECHNICAL ADVISORY COMMITTEE (TAC)

Linda Gorman-AAA Arizona, Stacey Stanton-MVD, Rick Turner-MVD, Karen King-Federal Highway Administration, Maria Wojtczak-Driving MBA, Charles Sobczak-Driving MBA, Jason Harris-Arizona Transportation Research Center, Jeff King-Department of Public Safety, Larry Talley-Multimodal Planning Division, Cindy Eiserman ADOT Risk Management, all members of the Strategic Highway Safety Plan Young Driver Team

SPR-680, *Development of Intersection Performance Measures for Timing Plan Maintenance Using an Actuated Controller – Phase II: Data Collection*

Research Agency:	Pending	FY Authorization:	2009
Principal Investigator(s):	Pending	Contract Date:	NA
Contract Amount:	Pending	Sched. Completion Date:	NA
Program Budget:	$75,000	Est. Completion Date:	NA
Expenditures to date:	0	On schedule?	NA
Available Amount:	$75,000	ADVANTAGE No.	R068021P
Percent complete Through 6/30/08	0%	Responsible ATRC Staff: (Project Manager)	Jason Harris

PROBLEM STATEMENT

Limited resources are available for maintenance of traffic signal timing plans. Because of this, it is important to ensure that resources are allocated to signals and corridors in need of retiming. The Highway Capacity Manual (1) (HCM) provides methodologies for development of quantitative measures (Arrival Type, V/C ratio, delay) to aid in analysis, however preparation of these measures through traditional methods is labor intensive (turning movement counts, travel time studies), and not often feasible, especially for hours that fall outside of the typical work day (special events, Saturday at the mall, etc). Because of this, it is desirable to have an automated method to tabulate data at signalized intersections.

RESEARCH OBJECTIVES

Phase II of this research focuses on Data Collection. The Phase II objective is to develop a data collection module to interface with existing Arizona Department of Transportation (ADOT) intersections, as well as create updated standards for new and rehabilitated intersections that would enable data collection at these locations.

EXPECTED IMPLEMENTATION

As part of this project, the module will be deployed at up to three (3) representative locations. Assuming the results of Phase II are deemed practical by the TAC, Phase III would develop a desktop computer data storage and management system for collected data, and more importantly, a user-friendly interface to mine data for input into desired software analysis tools (such as Synchro, HCS+, etc.).

STATUS OF THE RESEARCH

The project is not yet underway.

TECHNICAL ADVISORY COMMITTEE (TAC)

ADOT: Mike Manthey, Mike Lessard, George Chin, Reza Karimvand, Chuck Gillick, Bob LaJeunesse; Jeff Jenq, City of Mesa; Ron Dubek, City of Phoenix; Karen King, Federal Highway Administration

Transportation Research Quick Study (TRQS) Program

AZ-669, *Observational Study of Three Premium Prismatic Retroreflectivity Sign Sheeting Products Under Roadway Conditions*

Technology continues to improve sign sheeting products for use in traffic control devices. Recent products by two manufacturers are all offered as "superior" new products but their claims are essentially untested. This research project is designed to test these two competing products against each other and against one of the predecessor "superior" products using special signs in an actual freeway situation. The project will attempt to ascertain the differences, if any, among two relatively new "superior" sign sheeting products and one of the predecessor "superior" products.

The study will be a double-blind study meaning that neither the observers nor the analyst will know the names or manufacturers of any of the samples. Evaluation will be based on a double-blind, statistical analysis of the ratings of several observers. A statistical analysis will be performed on the observational data to determine the differences, or lack thereof, among the three sign sheeting products:

1. 3M VIP
2. Avery Dennison Omni View
3. 3M DG3

All the signs will be mounted on SR 202 Red Mountain Freeway from Power Rd to University Dr., prior to this roadway being opened to the public. Observers will rate the signs during nighttime driving conditions with the freeway lighting temporarily turned off.

Research Support Programs

SPR NO.	BUDGET ITEM	TOTAL BUDGET
110	**ATRC Library Resources**	**$ 120,404**

This budget item provides for the following services on an on-going basis:

Technical—Requests and receives new publications from federal, state, and private sources, classifies and catalogs new materials, maintains the library computer databases, maintains circulation records.

Service—Provides complete research assistance, including customized bibliographies from computer databases for Arizona Department of Transportation (ADOT) staff upon request, distributes library materials to ADOT staff, provides photocopies of articles upon request, provides interlibrary loans of books.

Public Awareness—Monitors the printing and distribution of all Arizona Transportation Research Center (ATRC) publications, coordinates the efforts taken to increase public awareness of ATRC, provides brief library presentations to ADOT staff upon request, maintains the ATRC Internet and Intranet sites.

111	**AASHTO and Transportation Research Board Correlation Service**	**$ 147,240**

This budget item is established to enable ADOT to participate in research studies initiated by the American Association of State Highway and Transportation Officials (AASHTO), implement the results of AASHTO work, and to support the annual subscription to the Transportation Research Board (TRB) Correlation Service. Dues for participation in AASHTO's National Transportation Product Evaluation Program (NTPEP) are provided by this item.

Research Support Programs

SPR NO.	BUDGET ITEM	TOTAL BUDGET
112	**Administration of Research**	**$ 149,285**

The budget for Administration of Research is based on the prior year's expenditures and the planned projection of activities for Fiscal Year 2002. The ATRC is responsible for initiation, technical review, coordination, and implementation of the research activities of ADOT. Other participating charges made to Administration are out-of-state travel expenses to national/regional conferences, short courses or seminars.

Other administrative costs are computer use, in-state travel, and office supplies. Research personnel are responsible for the publication of many reports derived from these activities. Payroll expenditures for secretarial service and typing are charged as overhead costs of operation of the ATRC, as well as graphic artwork and printing.

This budget item also provides for state services rendered in support of the SPR program. Examples include, but are not limited to, engineering consultant services and external/internal audits. Other costs include miscellaneous services, employee-related expenses, and membership in or support for professional organizations such as ITS America.

113 Support Staff Salaries $ 403,167

This budget item is established to provide the funding for additional staff support for the ATRC. The additional staff provides the expertise to manage and conduct research identified in the State Planning and Research (SPR) Program.

114 ADOT Meeting Support $ 36,480

This budget item provides support for ADOT employees to attend research related meetings and conferences. Allocation of these funds are subject to the approval of the ATRC Manager.

116 Product Resource Investment Deployment and Evaluation (PRIDE) $ 170,456

The PRIDE program coordinates the review and acceptance of new products for possible use by ADOT and maintains the Approved Products List (APL). The ATRC PRIDE program administrator coordinates the program with two Product Evaluation Committees: Materials, and Traffic Control.

117 Local Technical Assistance Program (LTAP) $ 117,496

This budget item is to identify the State's portion of the LTAP undertaking for this fiscal year. Annual renewal is subject to co-sponsorship by the Federal Highway Administration (FHWA).

Research Support Programs

SPR NO.	BUDGET ITEM	TOTAL BUDGET
118	**Transportation Research Quick Study (TRQS) Program**	**$ 40,008**

This budget item provides funds for specific research topic support. TRQS studies are limited to budgets of $5,000 or less.

124 Research Traffic Data Collection $ 317,196

This ongoing project supports traffic data collection and monitoring for the Long Term Pavement Performance (LTPP) program. Arizona is an active participant in the LTPP program. Under this program, ADOT constructed 111 test sections in support of the Specific Pavement Studies (SPS), 25 test sections in support of the General Pavement Studies (GPS), and 52 test sections in support of innovative materials research under the LTPP program. Vital to the successful outcome of this research is the simultaneous monitoring of traffic characteristics at these test sections. Resources under this project are employed towards the establishment of data collection sites (AVC: Automatic Vehicle Classification and WIM: high speed Weigh-In-Motion), and site operation, maintenance, calibration, data evaluation, and data management.

125 NCHRP $ 760,000

The National Cooperative Highway Research Program (NCHRP) is an applied, contract research program that develops near-term, practical solutions to problems facing transportation agencies.

127 Small Budget Studies $ 220,000

Since 1997, 28 small budget projects have been completed by the Arizona Transportation Research Center (ATRC). The Research Steering Committee has authorized an annual allotment of $200,000 specifically designated for small budget projects ($25,000 or less). These projects may be undertaken at any time during the year.

995 Director's Special Projects $ 50,000

These funds are set aside for projects requested by ADOT executive management at any time during the year.

996 Project Additions $ 40,000

These funds are available to fund expansions or additions to existing research projects.

997 Participation Projects $ 50,000

These are funds available for participation in research projects with other states.

Research Support Programs

SPR NO.	BUDGET ITEM	TOTAL BUDGET
998	**Budget Closeout Funds**	**$ 350,000**

Carry over funds from budget years that are closed out do not become available for 6-12 months after the budget year is closed down. These funds are used to finance active projects from the closed year until the rollover funds become available.

999	**Special Projects/Contingency**	**$ 764,904**

This is a placeholder for unused funds from completed projects and a reserve for project additions and executive management projects above the planned amounts. They can also be used to fund additional projects supported by the Research Council in either the major project selection process or the small budget program.

Pooled Fund Projects

Current Pooled Fund Projects

Project No.	National Studies	Obligated Amount	Project Manager
SPR-2(207)	Transportation Management Center (TMC) Study	(1)	Scott Nodes
SPR-3(020)	ENTERPRISE	$397,743	Frank Darmiento
SPR-3(072)	Internal Stability Design of MSE Walls	$10,000	Christ Dimitroplos
TPF-5(004)	Long Term Pavement Performance (LTPP) Specific Pavements Study (SPS) Traffic Data Collection	$300,000	Tom Kombe
TPF-5(037)	Southeast Superpave Center	$105,055	Christ Dimitroplos
TPF-5(085)	Transportation Security Plan	$25,000	Lonnie Hendrix
TPF-5(099)	Evaluation of Low Cost Safety Improvements	(2)	Jason Harris
TPF-5(105)	Transportation Library Connectivity	$5,000	Dale Steele
TPF-5(145)	Western Maintenance Partnership	$10,000	Lonnie Hendrix
TPF-5(166)	Application of Three-Dimensional Laser Scanning for the Identification, Evaluation, and Management of Unstable Highway Slopes	$30,000	Frank Darmiento
SPR-5(170)	Mobile Source Air Toxics (MSAT) From Major Highways	$70,000	Fred Garcia

(1) $80,000 provided by the Multimodal Planning Division
(2) $90,000 from Hazard Elimination and Safety funding

For additional information on these pooled fund projects see the Internet at: www.pooledfund.org

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Research Publications Catalogue

REPORTS LISTED BY REPORT NUMBER.

AZ-121	Final Report: Methods for Estimating the Magnitude and Frequency of Floods in Arizona. Roeske, R.H. Sept 1978.
AZ-123	Testing for Debonding of Asphalt from Aggregates. Jimenez, R.A. April 1973.
AZ-124	Final report - Phase 1: Structural design of Asphalt Pavements (Arizona). Jimenez, R.A. Oct 1972.
AZ-141-1	Soil Erosion and Dust Control on Arizona Highways Interim Final Report: Part 1: State of the Art Review. Sultan, Hassan A. Oct 1974.
AZ-141-2	Soil Erosion and Dust Control on Arizona Highways Interim Final Report, Part 2: Laboratory Testing Program. Sultan, Hassan A. Oct 1974.
AZ-141-3	Soil Erosion and Dust Control on Arizona Highways Progress Report, Part 3: Field Testing Program. Sultan, Hassan A. Nov 1974.
AZ-141-4	Soil Erosion and Dust Control on Arizona Highways Final Report: Field Testing Program. Sultan, Hassan A. Feb 1976.
AZ-144	Polymer Pavement Concrete for Arizona, Study 1. Popovics, Sandor. Nov. 1974
AZ-145	Field Stabilization of Chinle Clay By Electro-Osmosis and Base Exchange of Ions. Mancini, Frank P.; O'Bannon, Charles E. Oct 1975.
AZ-146	Frictional Properties of Highway Surfaces. Burns, John C. Aug 1975.
AZ-149	Field and Laboratory Evaluation of Debonding Test Procedures. Scott, Noel R.; Ritter, John B. March 1980.
AZ-150	Final Report; Phase 1 Asphalt Emulsion Treated Aggregates – Part 1: Laboratory Evaluation. Jimenez, R.A. June 1976.
AZ-151	Final Report: Methods and Parameters for the Use of Emulsified Asphalts for Prime Coats and Binders for Open-Graded Asphaltic Concrete Finishing Courses. Smith, Boyd; Nelson, Richard H. 1974
AZ-152	Implications of Statistical Quality Control of Portland Cement Concrete. Gonsalves, George F.D.; Eisenberg, John F. Jan 1975.
AZ-153	Experimental Moisture Determination for Defining Saturated Surface Dry State of Highway Aggregates. Dana, James S.; Peters, Rowan J. June 1974.
AZ-154	Polymer Pavement Concrete for Arizona; Study 2. Popovics, Sandor March 1976.
AZ-155	Development of a Network Optimization System: Appendixes. Kulkarni, R.; Golabi, K.; Finn, F.; Alviti, E. Aug 1980
AZ-156	Subgrade Elastic Modulus for Arizona Pavements: Final Report. Crossley, Robert W.; Beckwith, George H. Jan 1978. Subgrade Elastic Modulus for Arizona Pavements: Executive Summary. Crossley, Robert W.; Beckwith, George H. Jan 1978.
AZ-157	Environmental Factor Determination from In-Place Temperature and Moisture Measurements under Arizona Pavements. Way, George B. Aug 1980.
AZ-158-1	Utilization of Waste Boiler Ash in Highway Construction in Arizona – Part 1: Portland Cement Concrete. Rosner, John C.; Hamm, M. Kent. Dec 1976.
AZ-161	Development of Framework for a Pavement Management System for Arizona. Finn, F.N.; Kulkarni, R.; Mcmorran, J. Aug 1976.

Research Publications Catalogue

AZ-162-1	The Chemical and Physical Properties of Asphalt-Rubber Mixtures – Part 1: Basic Material Behavior. Green, E.L.; Tolonen, William J. March 1977.
AZ-164	Final Report – Phase 1: Testing Methods for Asphalt Rubber. Jimenez, R.A. Jan 1978.
AZ-167	Laboratory and Field Development of Asphalt Rubber for Use as a Waterproof Membrane. Frobel, R.K.; Jimenez, R.A.; Cluff, C.B. May 1977.
AZ-174	Optical Sieve Comparator Development Project. Poluianov, G.; Mancini, F.P. June 1979.
AZ-175	Field and Laboratory Evaluation of Sulfur Asphalt Patching Materials. McCullagh, Frank R. Aug 1982.
AZ-176	Sulfur-Asphalt and Aggregate Mixtures. Jimenez, R.A.; Meier, W.R. June 1981.
AZ-178	Laboratory Evaluation of a Chemical Coupling Agent to Prevent Debonding of Asphalts from Aggregates. Divito, Joseph A. Aug 1981.
AZ-179	Arizona's Salt Gradient Solar Pond. Hauskins, John B., Jr.; Mancini, Frank; Kolaja, Rudolf Oct 1987.
AZ-180	An Evaluation of Driver Behavior at Signalized Intersections. Wortman, R.H.; Matthias, J.S. Jan 1983.
AZ-181	Pavement Cracking Inventory Study. Mackenzie, James S. May 1982.
AZ-182	Overlay Deflection Design Method for Arizona. Eisenberg, John F.; Way, George B.; Delton, James P.; Lawson, John E. March 1983.
AZ-183	Analysis of Low Modulus Interlayers in Existing Pavements. McCullagh, Frank R.; Crabtree, Paul. 1983.
AZ-186	Laboratory Evaluation of Anti-Reflection Cracking Materials. Jimenez, R.A. Meier, W.R. Dec 1983.
AZ-187	Reactive Silane-Coupled Asphalt/Mineral Composites as Binders in Paving Construction. Faulkner, Jeffrey A. Dec 1983.
AZ-188	Evaluation of Methods to Control Debonding. Jimenez, R.A. Dec 1988.
AZ-189	Asphaltic Concrete Mix Design Evaluation. Jimenez, R.A.; Dadeppo, D.A. June 1986.
AZ-191	Optimization of Traffic Signal Change Intervals. Wortman, Robert H.; Fox, Thomas C. June 1986.
AZ-192	Left Turn Signal Warrants for Arizona. Matthias, J.S.; Upchurch, J.E. May 1985.
AZ-195-1	Vehicle Classification Procedure Study. Matthias, J.S.; Dean, A.G. June 1984.
AZ-196	Visual Processing and Driving Safety. Lindholm, Julie Mapes; Young, H. Hewitt; Radwan, A. Essam Nov 1986.
AZ-197	The Technical Feasibility, Socioeconomic Impact and Environmental Benefits of Alternate Energy Vehicles in the State of Arizona. Saczalski, Ken; Mullens, Lanny; Schnorr, Janet; Morgan, James. Aug 1986.
AZ-198-1	An Evaluation of Alternative Economic Inducements to Ridesharing for the Arizona Commuter – Vol. 1: Project Overview and Findings. Black, William C.; Plane, David A.; Westbrook, Robert A. June 1985.

Research Publications Catalogue

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AZ-201	Development of Data Measurement Techniques for Traffic Operations Analysis at Intersections. Wortman, Robert H.; Fox, Thomas C. June 1985.
AZ-202-1	Small Sign Support Analysis Phase 1: Crash Test Program. Ross, Hayes E., Jr.; Sicking, Dean L.; Campise, Wanda L.; Zimmer, Richard A. Aug 1988.
AZ-202-2	Small Sign Support Analysis Phase 2: Static, Pendulum and Full-Scale Crash Test Programs, Vol. 1 (Report). Ross, Hayes E., Jr.; Campise, Wanda L.; Schuler, Richard E.; Morgan, James R. Aug 1988.
AZ-202-3	Small Sign Support Analysis Phase 2: Static, Pendulum and Full-Scale Crash Test Programs, Vol. 2 (Appendices). Ross, Hayes E., Jr.; Morgan, James R.; Schuler, Richard E. Aug 1988.
AZ-202-4	Small Sign Support Analysis Phase 3: Benefit/Cost Analysis. Ross, Hayes E., Jr.; Sicking, Dean L.; Bligh, Roger P. Aug 1988.
AZ-204	Evaluation of Computer-Aided Drafting and Design Capabilities in the Highway Development Environment. Wakefield, William A.; Trujillo, Robert T. April 1988.
AZ-205-1	Information Systems in ADOT: An Analysis of Intra-Function Flow, Decision Support Needs, Existing Systems Utility and User Attitudes Vol. 1: Final Report. Moor, W.C.; Bailey, J.E.; Evans, P.A.; Roberts, A. March 1985.
AZ-205-2	Information Systems in ADOT: An Analysis of Intra-Function Flow, Decision Support Needs, Existing Systems Utility and User Attitudes Vol. 2: Manual for Evaluation of Needs and Attitudes of EDP Users. Moor, W.C.; Bailey, J.E.; Evans, P.A.; Roberts, A. March 1985.
AZ-205-3	Information Systems in ADOT: An Analysis of Intra-Function Flow, Decision Support Needs, Existing Systems Utility and User Attitudes Vol. 3: Appendices. Moor, W.C.; Bailey, J.E.; Evans, P.A.; Roberts, A. March 1985.
AZ-206	Brain Damage, Information Processing and Driver Capability. Lindholm, Julie Mapes; Inman, Vaughn W. Aug 1987.
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Research Publications Catalogue

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AZ-209-3	Comparative Assessment of Computer Programs for Traffic Signal Planning, Design and Operations – Vol. 3: Recommended Software Output. Radwan, A.E.; Sadegh, A.; Matthias, J.S.; Rajan, S.D. Dec 1986.
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AZ-210-2	Pedestrian Accidents in Arizona: An Investigation of Causative Factors and Recommendations for Safety Improvements – Vol. 2: Final Report. Matthias, J.S.; Stonex, A. May 1985.
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AZ-215	Low Solvent Emulsified Asphalt Study. Meier, W.R., Jr.; Feliz, Phillip D.; Schuster, Bernard R. June 1987.
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AZ-224 1976	Prevention of Reflective Cracking in Arizona Minnetonka-East (A Case Study). Way, George B. May 1976.
AZ-224-1	A Study of Travel Behavior for Retirement Communities – Vol. 1: Final Report. Shapiro, Phillip July 1986.
AZ-224-2	A Study of Travel Behavior for Retirement Communities – Vol. 2: Appendices and Survey Procedures. Shapiro, Phillip July 1986.

Research Publications Catalogue

AZ-225-1	An Analysis of the Effectiveness of Written Driver License Examinations in Evaluating Applicant Driving Abilities Task 1: Revisions of Test and Manual. Mcknight, A. James March 1985.
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AZ-227	Porous Pavement for the Control of Highway Runoff - Construction. Meier, W.R., Jr. Elnicky, Edward July 1988.
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Research Publications Catalogue

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AZ-250-2	Effects of In-Stream Mining on Channel Stability – Vol. 2: Final Report. Li, Ruh-Ming; Cotton, George K.; Zeller, Michael E.; Simons, Daryl B.; Deschamps, Patricia Q. June 1989.
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AZ-260-1	Sizing Riprap for the Protection of Approach Embankments and Spur Dikes and Limiting the Depth of Scour at Bridge Piers and Abutments – Vol. 1: Literature Review and Arizona Case Histories. Li, Ruh-Ming Macarthur, Robert Cotton, George June 1989.
AZ-260-2	Sizing Riprap for the Protection of Approach Embankments and Spur Dikes and Limiting the Depth of Scour at Bridge Piers and Abutments – Vol. 2: Design Procedure. Li, Ruh-Ming; Macarthur, Robert; Cotton, George. June 1989
AZ-261	Driver Improvement Index. McKnight, James A. June 1988.
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AZ-264-1	Evaluation of Concrete Pavements in the Phoenix Urban Corridor – Vol. 1: Final Report. Smith, K.D.; Peshkin, D.G.; Mueller, A.L.; Owusu-Antwi, E.; Darter, M.I. Sept 1991.
AZ-264-2	Evaluation of Concrete Pavements in the Phoenix Urban Corridor – Vol. 2: Appendices. Smith, K.D.; Peshkin, D.G.; Mueller, A.L.; Owusu-Antwi, E.; Darter, M.I. September 1991.
AZ-278	Present Status of Management and Technical Practices on Alluvial Fan Areas in Arizona. Ward, Robert L. Nov 1988.
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AZ-282	Socioeconomic and Land Value Impact of Urban Freeways in Arizona. Tomasik, Jack Oct 1987.
AZ-282	Socioeconomic and Land Value Impact of Urban Freeways in Arizona: Executive Summary. Tomasik, Jack Oct 1987.
AZ-288	Safety and Operational Impacts of Raising the Speed Limit to 65 mph. Upchurch, Jonathan; Rahman, Mushtaqur April 1989.

Research Publications Catalogue

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AZ-321	Comparative Analysis of Leading and Lagging Left Turns. Lee, Jim C.; Wortman, Robert H.; Hook, David J.P.; Poppe, Mark J. Aug 1991.
AZ-322	Forensic Pavement Analysis. Denicholas, Maralou April 1990.
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AZ-350	Laboratory Evaluation of Typical ADOT Asphalt Concrete. Mamlouk, Michael S.; Khanal, Punya P. Aug 1990.
AZ-352	Porous Pavement for Control of Highway Run-Off. Hossain, Mustaque; Scofield, Larry A. July 1991.
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AZ-368	Processes for the Design of Large Stone Mixtures: A Review. Jimenez, R.A. Jan. 1993.
AZ-371	Assessment of Research Project SPR 371, Maintenance Cost Effectiveness Study. Peshkin, David G. May 2006.
AZ-372-1	Cost/ Benefit and Risk Assessment Procedure for the Product Evaluation Program – Vol. 1: Product Evaluation Model Final Report. Lewis, David; Liner, Doug; Harvey, Jonathan. Jan 1995.
AZ-372-2	Cost/Benefit and Risk Assessment Procedure for the Product Evaluation Program – Vol. 2: Product Evaluation Model Reference Manual and User's Guide. Lewis, David; Liner, Doug; Harvey, Jonathan. Jan. 1995.
AZ-377-1	Construction Report for Arizona's SHRP SPS-4 Experiment. Meier, W.R., Jr.; Elnicky, Edward J. Aug 1992.

Research Publications Catalogue

AZ-377-2	Construction Report for Arizona's SHRP SPS-4 Experiment: Appendices. Meier, W.R., Jr.; Elnicky, Edward J. August 1992
AZ-379-1	SPS-5 and SPS-6 SHRP Data Collection. Dec 1992.
AZ-383	RHODES Project: Phase II(A). Head, Larry; Mirchandani, Pitu. July 1994.
AZ-384	Human Factors in IVHS: Age, Driving Stress and Health. Sadalla, Edward K. Dec 1994.
AZ-386	Test and Evaluation of Arizona Slip-Away Base Luminaire Supports. Bligh, Roger P.; Ross, H.E.; Bullard, D.L. Nov 1994.
AZ-387	LTPP Traffic Data Collection and Monitoring. Kombe, Estomih M. May 1998.
AZ-402	Evaluation of Moisture Sensitivity Properties of ADOT Mixtures on US 93, v.1. Sebaaly, Peter E.; Eid, Zein; Epps, Jon A. November 2001.
AZ-416	I-10 / I-17 Phase I FMS Evaluation. Witkowski, James M.; Summers, George; Mouasher, Faris; Marum, Michael J. July 1997.
AZ-418	Customer-Oriented Level of Service Maintenance Management System. December 2005.
AZ-421	Investigate the Effects of Driving Stress on Health. Sadalla, Edward K. June 1995.
AZ-422	Strategic Plan for ITS Communication. Gunn, James; Abernethy, Bruce. March 1996.
AZ-441	Arizona Transportation Technology Transfer Resource Catalog. Lima, Peter. July 1995.
AZ-447	RHODES - ITMS Tempe Field Test Project: Implementation and Field Testing of RHODES, a Real-Time Traffic Adaptive Control System. Mirchandani, Pitu; Lucas, David E. September 2001.
AZ-448	Strategy Development for Dust Control and Prevention on I-10. Cowherd, Chatten; Grelinger, Mary Ann; Blackburn, Robert; Karimvand, Reza. June 1997.
AZ-450	Bridge Approach / Anchor Slab Joint Evaluation. Sundaram, Shan; Dadik, Michael. July 1997.
AZ-451	Integrated Sign Management System - ADOT Maintenance Group. Mueller, Kurt; Waters, Cheryl; Ohde, Diane December 2003.
AZ-452	How Do You Collect and Use Public Information in the Development of Transportation Plans and Programs?. Lindstrom, Matthew; Nie, Martin. March 1997.
AZ-453	The Cost Effectiveness and Magnitude of Potential Impact of Various Congestion Management Measures. Rowell, Matthew; Buonincontri, Frederic; Semmens, John. March 1997.
AZ-454	Integration of ISTEA and Databases. Roetzheim, William. Aug 1997.
AZ-455	Development of New Pavement Design Equivalent Single Axle Load (ESAL). Alavi, Sirous H.; Senn, Kevin A. Sept 1999.
AZ-457	Strategic Plan for Statewide Deployment of Intelligent Transportation Systems in Arizona. Wall, Henry; Kolcz, Andrew Dec 1998.
AZ-458	Identifying and Implementing Corridor Safety Improvements: A Highway Safety Improvement Process and Safety Analysis Tools for Arizona. Breyer, Jerome P.; Joshua, Sarath C. Feb 1999.

Research Publications Catalogue

AZ-460	Performance Evaluation of Cold In-Place Recycling Projects in Arizona. Mallela, J.; Von Quintus, H.L.; Smith, K.L. March 2006.
AZ-461	Procedures for Winter Storm Maintenance Operations. Boselly, S. Edward; Blackburn, Robert R.; Amsler, Duane E. October 2005.
AZ-462	RHODES-ITMS Corridor Control Project. Gettman, Douglas; Head, Larry; Mirchanddani, Pitu. May 1999.
AZ-463	Arizona Quality Initiative Survey of Highway Users and Community Leaders. Hernandez, Bruce. July 1997.
AZ-464	PECOS - ITI Data Models. Joshua, Sarath C. June 1998.
AZ-465-1	Effectiveness of Videoconferencing – Phase 1: Pre-Pilot Test Report. Jian-Xiang, Zhang Nov 1998.
AZ-465-2	Effectiveness of Videoconferencing – Phase II: Post-Pilot Test Report.. Jian-Xiang, Zhang; Semmens, John. September 2000.
AZ-466	Fuzzy Variable Speed Limit Device Project. Placer, John; Sagahyroon, Assim. Aug. 1998.
AZ-466-2	Fuzzy Variable Speed Limit Device Modification and Testing - Phase II. Placer, John. July 2001.
AZ-467	Effective Countermeasures to Reduce Accidents in Work Zones. Walker, Vicki; Upchurch, Jonathan. Nov 1999.
AZ-468-1	Accelerated Pavement Testing - Phase 1. Owusu-Antwi, Emmanuel; Mamlouk, Michael; McCullagh, Frank. March 2000.
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AZ-472	University Research Center, Phase 1. Walker, Vicki July 1998.
AZ-472-2	University Research Center: Phase II. Aarons, Barry March 1999.
AZ-473-1	Arizona Intelligent Vehicle Research Program – Phase One: 1997- 2000. Owen, Stephen R. February 2001.
AZ-473-2	Arizona Intelligent Vehicle Research Program – Phase Two: 2000 - 2001. Owen, Stephen R. May 2002.
AZ-473-3	Arizona Intelligent Vehicle Research Program – Phase Two(B): 2001 - 2002. Owen, Stephen R. September 2003.
AZ-473-4	Arizona Intelligent Vehicle Research Program – Phase Three: 2002- 2003. Owen, Stephen R. January 2004.
AZ-473b	VISTA – Vehicles With Intelligent Systems for Transport Automation. Wang, Fei-Yue; Mirchandani, Pitu; Kuo, C.Y. November 2000.
AZ-474	Development of Statewide GIS-Based Features Inventory System, Summary Report. Ohde, Diane. December 2005.
AZ-475-1	The Value of Arizona's State Highway System: A Corporate Style Financial Analysis. Mansour, Nadia; Semmens, John. Sept 1999.
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AZ-476	Vehicle Emission Noise Evaluation for Arizona Specific Stamina 2.0 and Traffic Noise Model (TNM). Cohn, Louis F.; Harris, Roswell A.; Frederick-Harbour, Kari; Goldsmith, Jane. June 2000.

Research Publications Catalogue

AZ-477-1	1999 Update of the Arizona Highway Cost Allocation Study. Carey, Jason Aug. 1999.
AZ-477-2	Refinement of the Simplified Arizona Highway Cost Allocation Study Model. Carey, Jason. Sep. 2000.
AZ-477-3	Implementation of the Simplified Arizona Highway Cost Allocation Study Model. Carey, Jason. March 2001.
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AZ-480	Rural Highway Mayday Deployment Plan. Hansen, Sharon; Breyer, Joe; Kolcz, Andrew. May 1999.
AZ-481	RHODES - ITMS - MILO Ramp Metering System Test. Ciarallo, Frank W.; Mirchandani, Pitu. April 2002.
AZ-482	Continuous Evaluation of In-Service Highway Safety Feature Performance. Mak, King K.; Sicking, Dean L. Sep. 2002.
AZ-483	Optimization of Drilled Shaft Group Spacing: Interim Report. Walsh, Kenneth D.; Houston, William N.; Houston, Sandra L.; Frechette, Daniel N.; Douthitt, Brent. Nov. 1999.
AZ-484-1	Arizona Highway User Origin and Destination Survey. Jan. 2000.
AZ-484-2	Traffic and Expenditures on Arizona State Highways. Matranga, Eric; Semmens, John. June 2000.
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AZ-486	Highway Facilities for an Aging Arizona Population. Baggett, Sharon A. June 2003.
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AZ-491	Evaluation of the Cost Benefits of Continuous Pavement Preservation Design Strategies Versus Reconstruction. Smith, K.L.; Titus-Glover, L.; Darter, M.I.; Von Quintus, H.L.; Stubstad, R.N.; Hallin, J.P. Sep. 2005.
AZ-492	Enhancing Arizona Department of Transportation's Traffic Data Resource. Sterling, James; Hossak, Steve; Bills, Terry. May 2001.
AZ-494	Development and Implementation of Arizona Department of Transportation (ADOT) Pavement Management System (PMS). Zaghloul, Sameh; Helali, Khaled; Bekheet, Wael. April 2006.
AZ-495	A Field Study of Particulate Emissions for Major Roadways in the Phoenix Airshed. Anderson, James; Moore, Gordon; Fernando, J.H.S.; Hyde, Peter. March 2006.

Research Publications Catalogue

AZ-496	Effective Control Measures at High Particulate Pollution Areas: Analysis of Data from the 2002 Phoenix Greenwood Study. Stoeckenius, Till; Rao, Sandhya. June 2005.
AZ-497	Arizona Statewide Incident Management Plan. O'Laughlin, John B. July 2000.
AZ-501	Evaluation of Operational Efficiencies, Cost, and Accident Experience of Four Phase Single Point Urban Interchanges. Lee, Jim C.; Bonneson, James A.; Kidd, Brennan D.; Larwin, Thomas F., Jr. March 2002.
AZ-502-1	ADOT Uses for Virtual Private Networking Technology: Phase 1 - Pre- Pilot Test Report. Merkow, Mark. Feb. 2001.
AZ-502-2	ADOT Uses for Virtual Private Networking Technology: Phase 2 - Final Test Report. Merkow, Mark; Nacinovich, Rich; Drew, Nicole. Feb. 2002.
AZ-503	State-Of-The-Art Report on Non-Traditional Traffic Counting Methods. Skszek, Sherry L. October 2001.
AZ-504	Arizona Local Government Safety Project Analysis Model. Carey, Jason. June 2001.
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AZ-518	Arizona Department of Transportation Project Delivery Cycle Time Analysis. Rose, David C. Oct. 2005.
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Research Publications Catalogue

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AZ-531	Development of a Plan for Compliance With NCHRP 350 for Temporary Concrete Barriers. Zubi, Muhannad; Riley, Annette. June 2002.
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AZ-542 v.1	Congestion Mitigation Resources and Strategies for Arizona's State Highway System, v.1: Research Goals, Activities and Conclusions. Amin, Nayan S.; Sapkota, Virginia A.; Christensen, Cody T. Oct. 2002.
AZ-542 v.2	Congestion Mitigation Resources and Strategies for Arizona's State Highway System, v.2: Congestion Mitigation Strategies Resources. Amin, Nayan S.; Sapkota, Virginia A.; Christensen, Cody T. Oct. 2002.
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Research Publications Catalogue

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AZ-570	Rural ITS Progress Study - Arizona 2004. Wendtland, Michael; Kolcz, Andrew; Christenson, Ryan. Dec. 2004.
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Research Publications Catalogue

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AZ-702	Port of Entry Weigh-In-Motion Feasibility Study. Denicholas, Maralou. March 1989.

Research Publications Catalogue

STATE OF THE ART REPORTS

AZ-801	Flood Frequency Methods for Arizona Streams: State of the Art. Reich, Brian M. October 1988.
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Research Publications Catalogue

EXPERIMENTAL PROJECTS

AZ-7904.....Performance of Concrete Joint Sealants in Hot Climates. McCullagh, Frank R.; Wolfe, Timothy W.; D'Souza, Melville. November 1987.

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AZ-8401 .....Product Evaluation: Bituminous Pavement Rejuvenator. Scofield, Larry; Wolfe, Timothy M. July 1986.

AZ-8408 .....Product Evaluation: Thoro Product Demonstration. Tritsch, Steven L.; Wolfe, Timothy M. July 1986.

AZ-8410.....Product Evaluation: Ruscoe 983 Joint Sealant. Tritsch, Steven L.; Wolfe, Timothy M. July 1986.

AZ-8604 .....Crack and Seat Concrete Pavement. Osseiran, Abdallah H. September 1987.

AZ-8604 1989.....Three Year Evaluation of I-40 Crack and Seat Experimental Project. Hossain, A.S.M. Mustaque; Scofield, Larry A. October 1989.

AZ-8618 .....Joint Sealant Study, [Product Evaluation 86-18 Joint Sealant Study: Construction Report]. Wolfe, Timothy M.; Tritsch, Steven L. September 1987.

AZ-8801 .....Paving Fabrics for Reducing Reflective Cracking. Rahman, Mushtaqur; Scofield, Larry; Wolfe, Timothy. December 1989.

AZ-8801 1991.....Paving Fabrics for Reducing Reflective Cracking. Rollins, Greg; Rahman, Mushtaqur; Scofield, Larry A.; Kalevela, Sylvester. November 1991.

AZ-8802/8803.....SENTRE and TREND Attenuator Field Installations. Lattin, Douglas J. February 1990.

AZ-8802/8803 1991...SENTRE and TREND Attenuating Systems: Final Report. Rollins, Greg; Scofield, Larry A. July 1991.

SPECIAL REPORTS

Sp-8902.....The History, Development, and Performance of Asphalt Rubber at ADOT. Scofield, Larry. December 1989.

Sp-9101.....A Review of the Dragnet Vehicle Arresting System as Applied to Runaway Truck Escape Ramps. Metcalf, Dwight. June 1991.

Sp-9202.....Small Sign Support Investigation. Ho, Yee-Jung (Al); Metcalf, Dwight; Kalevela, Sylvester. May 1992.

Sp-9204.....Analysis of Arizona Arrestor Bed Performance. Metcalf, Dwight; Zaniewski, John; Duffy, Dennis. June 1993.

Sp-9301.....Pavement Network Optimization and Implementation. Wang, Kelvin C.P.; Way, George; Delton, James; Zaniewski, John. February 1993.

Sp-9302.....Evaluation of Initial Pavement Smoothness for the Development of PCCP Construction Specifications. Kombe, Estomih, Kalevela, Sylvester. March 1993.

Sp-9303.....Construction Report for Crash Cushion Attenuating Terminal. Kalevela, Sylvester. June 1993.

Sp-9304.....Review of Retroreflective Sign Sheeting Materials, Practices and Policies. Flintsch, Gerardo W. October 1993.

Sp-9603.....A Study of The Relationship Between Left Turn Accidents and Driver Age in Arizona. Matthias, Judson S.; De Nicholas, Maralou E.; Thomas, Gary B. December 1996.
Sp-9701.....RHODES – ITMS. Head, Larry; Mirchandani, Pitu. April 1997.
Sp-9702.....Expert Project Recommendation Procedure for ADOT's Pavement Management System. Flintsch, Gerardo W.; Zaniewski, John P.; Delton, James. August 1997.

.

MISCELLANEOUS REPORTS

Current and Future Studies of Asphaltic Concrete Mixtures. Presentation; 49th WASHO Conference; Anchorage, AK: Oct 11-16, 1970. Peters, Rowan J. October 1970.
Asphalt Cement Durability and Aggregate Interactions: Final Report. Peters, Rowan J. April 1973.
A Study of the Arizona Design Criteria for the Prevention of Stripping of Asphaltic Concrete: Final Report. Way, George B. August 1974.
Differential Friction Related to Skidding. Presentation at the Twenty-Fourth Annual Arizona Conference on Roads and Streets; April 17- 18, 1975. Burns, John C. April 1975.
Asphalt-Rubber Membranes; Development, Use, Potential. Morris, G.R. 1975.
Differential Friction: A Potential Skid Hazard. Presentation at the Fifty-Fifth Annual Meeting of the Transportation Research Board; Washington, DC: Jan 1976. Burns, John C. January 1976.
Pavement Recycling Project: I 8-2 (76) Yuma County Line - Gila Bend Demonstration Project 39, NEEP 22. Arizona DP-39. Ritter, John B. October 1978.
Asphaltic Concrete Variance and What It Means in Terms of Future Pavement Performance. GW-2. Way, George B.; Jones, Hollis. August 1979.
Using a Dryer Drum in the Construction of Sulfur Extended Asphalt (SEA) Pavements: Executive Summary Report.
AZ-IP44. McCullagh, Frank R. September 1979.
Evaluation of Road Surfaces Utilizing Asphalt Rubber: 1978. GG-3. Gonsalves, George F.D. November 1979.
Hot Mix Recycling: Design and Control on IR-I-17-2(85): Interim Report. Howard, Robert L.; Colwell, Ernest W. August 1981.
An Evaluation of Sulphlex-233/A as a Binder Material. Interim Report: Design and Construction. McCullagh, Frank. July 1982.
Final Report: Arizona Highway User Revenue Fund Forecasting Model. Boyes, William J.; Farris, Martin T.; Hoffman, Dennis L.; McPheters, Lee R.; Sale, Suzanne; Schlagenhauf, Don E.; Bullion, Karen; Kohlbrenner, Daniel. July 1982.
Short Term Highway User Revenue Fund Forecasting Model. Boyes, William J.; Farris, Martin T.; Hoffman, Dennis L.; McPheters, Lee R.; Schlagenhauf, Don E. July 1982.
User's Guide: Arizona Highway User Revenue Fund Forecasting Model. Boyes, William J.; Farris, Martin T.; Hoffman, Dennis L.; McPheters, Lee R.; Sale, Suzanne; Schlagenhauf, Don E. July 1982.
An Assessment of Optimizing Highway Improvement Prioritization. Witkowski, J.M.;Shropshire, D.A. August 1982.

Research Publications Catalogue

Design, Construction and Performance of a Sulfur-Extended-Asphalt (SEA) Pavement Built with Material Produced by a Dryer-Drum Plant: Executive Summary Report. IP-44. McCullagh, Frank R. September 1982.

The Three Layer System on Arizona Highways: Development and Analysis. Presentation at the Twenty-First Idaho Asphalt Conference. Sarsam, Jamal B., Morris, Gene R. November 1982.

An Evaluation of Computer Models to Predict the Erosion and Deposition of Sediment for Selected Streams in Arizona. Bowers, Mark T.; Ruff, Paul F. August 1983. An Evaluation of Sulphlex-233/A as a Binder Material. Interim Report: Design and Construction. McCullagh, Frank. July 1982.

Final Report: Arizona Highway User Revenue Fund Forecasting Model. Boyes, William J.; Farris, Martin T.; Hoffman, Dennis L.; McPheters, Lee R.; Sale, Suzanne; Schlagenhauf, Don E.; Bullion, Karen; Kohlbrenner, Daniel. July 1982.

Short Term Highway User Revenue Fund Forecasting Model. Boyes, William J.; Farris, Martin T.; Hoffman, Dennis L.; McPheters, Lee R.; Schlagenhauf, Don E. July 1982.

User's Guide: Arizona Highway User Revenue Fund Forecasting Model. Boyes, William J.; Farris, Martin T.; Hoffman, Dennis L.; McPheters, Lee R.; Sale, Suzanne; Schlagenhauf, Don E. July 1982.

An Assessment of Optimizing Highway Improvement Prioritization. Witkowski, J.M.;Shropshire, D.A. August 1982.

Design, Construction and Performance of a Sulfur-Extended-Asphalt (SEA) Pavement Built with Material Produced by a Dryer-Drum Plant: Executive Summary Report. IP-44. McCullagh, Frank R. September 1982.

The Three Layer System on Arizona Highways: Development and Analysis. Presentation at the Twenty-First Idaho Asphalt Conference. Sarsam, Jamal B., Morris, Gene R. November 1982.

An Evaluation of Computer Models to Predict the Erosion and Deposition of Sediment for Selected Streams in Arizona. Bowers, Mark T.; Ruff, Paul F. August 1983.

PRIDE (Product Evaluation Program) Annual Report. 2001. 2002.